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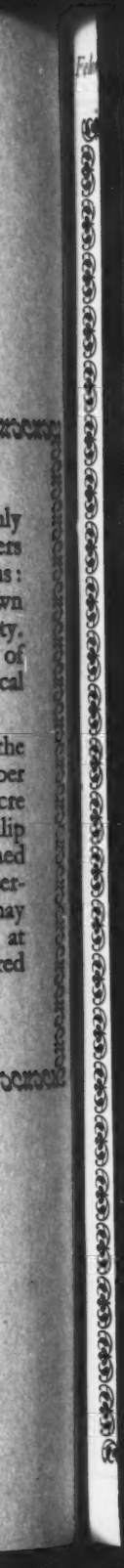

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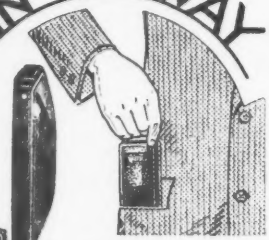

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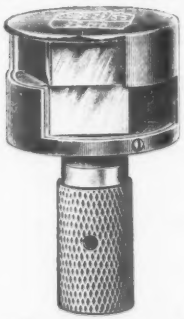

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The GEOGRAPHICAL JOURNAL

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RIVER EXPLORATION IN LABRADOR BY CANOE AND DOG SLEDGE: *A paper read at the Evening Meeting of the Society on 4 November 1929, by*

H. G. WATKINS

IT was the Canadian dispute with Newfoundland which first drew people's attention to the possibilities of Labrador. Up to that time it had always been dismissed as "the Land that God gave Cain," and few people had thought that it could be worth anything. Now people began to think about it more carefully. Perhaps there were minerals, certainly there were rich forests and plenty of water-power.

Although so close to Canada, Labrador has remained very much a *terra incognita*. Even the charts of the coast are out of date and inaccurate, and much of the interior is almost completely unknown. The Canadian geologist A. P. Low made several long journeys across Labrador in 1892 to 1895, and on these journeys thin lines of country were mapped. The vast country on either side of these lines still remained unknown. Since the epoch of his journeys there have been a few expeditions to the interior, but they have not covered a great deal of new country.

The most interesting part of Labrador both geographically and economically is the Grand Falls district. Grand Falls itself lies on the Hamilton River about 250 miles from its mouth. This river is by far the largest in Labrador. Two main branches, the Attikonak and the Upper Hamilton or Ashuanipi, unite above the Grand Falls at Sandgirt Lake, the Attikonak being the larger. It starts from Lake Attikonak, flows first in a north-westerly direction, and then makes a sharp bend from north to south-east about 45 miles above the Grand Falls.

Low reported the existence of two fairly large rivers flowing into the Hamilton from the south just below the exit of Bowdoin Cañon. One was shown on his map as the Valley River; the other was mentioned in his report and has since been called the Unknown River. No one knew where they came from; but there seemed only two possibilities. They might be draining some large lake just to the south of the Hamilton, or they might be branches connecting Lake Ossokmanuan on the Attikonak with Hamilton River just below the falls.

Low evidently thought the latter, since in his map he dotted in the supposed course of Valley River, between lake Ossokmanuan and Hamilton River. In that case one or both rivers would be acting as a short cut across the great bend in Hamilton River, and it seemed possible that a large part of the water which now flows over Grand Falls might be diverted and eventually flow down these two streams. Before the power of Grand Falls could be developed, it would obviously be necessary to know this.

In 1921 Thomas, a Canadian traveller, discovered twin falls on Unknown River. The river was divided by an island, on each side of which there was a fall. Since Thomas's journey the most northerly of these twin falls has been visited by Frissell. He journeyed across from Grand Falls to the twin falls and crossed Valley River on the way, finding very little water flowing in it. He was able to get some very excellent photographs of the northerly fall, but was unable to photograph the other fall, as he could not cross the river to the island. On his way back to Hamilton River he kept to the west of his outward route, and although he crossed two very small streams, he never crossed any large river. This made it almost certain that Valley River could not come from Lake Ossokmanuan, but there was still the possibility that Unknown River might come from this lake (see *G.J.*, 69, 332, April 1927, and 70, 287, September 1927).

The object of our expedition was to explore the Unknown River region in the hopes of clearing up some of the problems which have already been mentioned. We also hoped to make some journeys into the country north and south of the Hamilton for the purpose of mapping out some of the rivers and lakes, with a view to a future aerial survey (which will be the only satisfactory way of mapping Labrador). We also had another object, which was to locate the exact position of the Height of Land near the head of the Romaine and to map the upper part of the Romaine itself. In this way we should have mapped a very important part of the boundary between Labrador and Canada, which is defined at this point as following up the Romaine to its source, and from there striking due north to the Height of Land and following this along.

We were unsuccessful in this last object, as we were prevented by various circumstances from doing the work which we had planned on the boundary. However, we managed to do the rest of the work which we had contemplated. We were able to clear up most of the problems in the Unknown River district, and were also fortunate to discover some new falls. We also did two further journeys, a southern and a northern. On the southern journey we were able to map the Kenamu River to its source and also most of the Traverspine. On the northern journey we were able to map a line of country between Northwest River and Hopedale, and we also found a very suitable place to use as a base for an aerial survey of the interior. Apart from those main journeys we were able to map Grand Lake, which is a lake 40 miles long close to Northwest River. We did one further sledge journey when we had finished our work in the interior. This was from Northwest River round the Labrador coast to Bonne Espérance, in Canada. On this journey we had no mapping to do.

Southern Labrador is so thickly wooded that it is impossible to do any plane-table work. Even the high hills are usually covered in trees, and for the most part it is an undulating country with no outstanding peaks. As a consequence

of this, on all our journeys the surveying was done by means of prismatic compass traverses checked by astronomical positions.

The expedition consisted of J. M. Scott, L. A. D. Leslie, and myself. The Royal Geographical Society very kindly gave a grant of £300 towards the expenses, and also lent all the surveying instruments. Another grant of £40 was made by the Worts Fund, of Cambridge, and there was also the Cuthbert Peek Grant.

We assembled in St. Johns, Newfoundland, at the beginning of July 1928, and on Friday July 13 we set off northward on the Labrador mail steamer which calls at all the little settlements on the coast. It took us only about a week from St. Johns to Rigolet, on Hamilton Inlet, which was as far as we could go towards our base by the steamer. Here we were dumped ashore with all our stores and equipment for one year. Our base was to be at Northwest River a settlement and post of the Hudson's Bay Company, 90 miles up Lake Melville, and the Roman Catholic missionary very kindly gave us a lift in his motor boat for that distance. We arrived at Northwest River on July 20.

I had chosen Northwest River as our base owing to its position at the mouth of Hamilton River. It is thus on the very edge of all the unexplored territory. In spite of this, during the summer it is easily approached from the outside world. The population of Northwest River consists of about 150 people, the descendants of the old English and Scottish settlers who first came to Labrador. Most of these settlers married Indians or Eskimo and the present population shows many characteristics of these people. In stature they are short and broad, and they have very black hair and dark skins. They are good-natured people, and always seem happy and contented. The whole population lives by trapping. In the autumn the men set off with their provisions in canoes up the rivers. They sometimes go as much as 200 miles to their hunting-ground.

Each man works alone, living in a little log shack. He has a line of traps which it takes him about five days to visit, and when he gets back to his shack it is time to start the next round. Although each man is alone for months at a time, he never has a dull moment, since all his spare time is spent in stretching and drying his skins or in mending his snowshoes or sledge. At the end of December the trappers begin to arrive back at Northwest River one by one, dragging behind them their sledges on which their furs are piled. Now follows a time of gaiety and rejoicing lasting till well past the beginning of the new year. Then off they start again with provisions enough to last them until "open water" the next spring. At "open water" comes the most hazardous part of the trapper's existence, the wild dash by canoe down the swollen rivers, every man risking his life and his precious load of furs in each of the rapids. By the end of June all the trappers are back at Northwest River. Then follow three months of complete rest, with nothing to do except eat, sleep, and fish. Then once more they go off for the winter. A good trapper will make between three and four hundred pounds in a year. Nearly all the trappers are excellent rifle shots, and indeed it is not surprising when one considers the amount of practice they get. It is possible any day to see little children five or six years old shooting from canoes on the water with their own express rifles. Apart from the trapping population of Northwest River there is the Hudson's Bay Company's Manager with two clerks under him. The Company buys all the furs which the

trappers get, and sells them food and equipment. Then there is the Grenfell Hospital, a large and comfortable building run by a doctor and a nurse; to this is attached a small school run by the Grenfell Association for the children of the trappers.

Labrador puts many difficulties in the way of the explorer, but the greatest of these is the fact that he cannot rely on finding fresh meat for his food supply. As a consequence of this we had to take all our food with us on our journeys. Although we did sometimes get fresh meat, our rations consisted essentially of pemmican, biscuits, chocolate, sugar, cocoa, plasmon oats, plasmon and marmite. Taken in certain proportions these form an ideal sledging ration for hard work in cold weather. Since this ration contains no vitamin C, we took with us a special anti-scorbutic preparation of lemon-juice. Actually we found this to be unnecessary, since a very effective anti-scorbutic can be prepared by boiling spruce in water. When travelling in a country where it is possible to get fresh meat, it is far better to live on meat alone, using no other food to supplement it. Fresh meat contains everything necessary to support life, and if some of it is eaten raw it is far more efficient than the best sledging rations. There is no more healthy food than fresh seal meat and fat.

Owing to the difficulty of transporting large quantities of supplies and equipment through thickly wooded country in winter, we decided that it would be best to try the long journey to the Unknown Falls district in the summer, so on July 25, after four days' hectic preparations, we started off up Grand River in our two heavily laden canoes. We had with us one trapper, Robert Michelin, whom I had decided to take so that he could hunt for us while we were surveying, and also because he knew all the Indian portage routes within a 50-mile radius of Northwest River. He turned out to be a most excellent fellow, a good worker and very intelligent. He and six other trappers from Northwest River had joined up with the Newfoundland regiment at the beginning of the war, and they had all seven been made snipers on account of their excellent shooting. I learnt from Robert Michelin that he had thoroughly enjoyed the whole thing; when I asked him where he had been fighting he replied that he rather fancied it was somewhere called France! He returned to Northwest River in 1918 with a bullet through his leg; but in spite of this misfortune he is still the fastest snowshoe walker among the trappers.

Unfortunately our attempt to reach the Unknown River district was a complete failure. After we had been out for nearly two weeks, Michelin cut his foot with an axe and we had to return. It took us only three days to descend the rapids which it had taken us nearly two weeks to ascend.

We now had to review our position and decide upon a new programme. It was obvious that we should not have time to do the work near Unknown River during the summer, since it was already getting late in the year. But to do the journey in the winter would not be nearly so satisfactory, since without canoes it is impossible to transport sufficient supplies for a very long time, and consequently we should not be able to do the work as thoroughly as we had hoped. It would also be impossible to do any work on the boundary during the winter, since all the small streams on the height of land would be frozen up and covered in snow, and it would be impossible to tell in which direction they were flowing. We decided therefore that during the remainder of the summer we would do a

Camp at the mouth of a tributary of the Kenamu

Hauling sledges up a hill in wooded country

An autumn camp: river still open in the centre

journey into the country to the south of our base, following up the Kenamu river to its head, then portaging across to the Traverspine, and descending by this to the Hamilton. In this way we should be able completely to map these two rivers, and we also hoped to learn a good deal about the surrounding country. After this I decided our next journey should be into the country north of our base. We should thus leave the Unknown River journey until the end of the winter, when we should be likely to encounter the best weather.

The Kenamu and Traverspine

By August 20 Robert Michelin's foot was healed and we were able to start off up the Kenamu. We had with us this time an extra trapper, Douglas Best, who was very anxious to come with us, as he himself had trapped on the lower part of the river. For the first day or so the river was calm and sluggish, and we had an easy time paddling. The country on each side of the river was low marsh land stretching from the shores of Lake Melville back to the Mealy Mountains, which start about 30 miles south of the lake. Once we reached these mountains our troubles really began. The river narrows and is extremely rough and rapid. We were hardly ever able to sit in the canoes, but were usually wading in the river, one man holding the front of a canoe and one the back. Sometimes when the river was not too rough, we were able to tow the canoes by a line from the bank, and in this way to move more rapidly. Frequently the river became so rough that we had to portage everything through the woods. At the beginning of our journey this was extremely hard work, as we each had to make three or four journeys carrying about 70 lbs. weight each time. Later on, however, the loads became lighter as our food gradually disappeared. Once we had got through the Mealy Mountains travelling became easier. The river widened out into a series of lakes connected by small rapids. We followed it up until it became so small that we could jump across it, and then decided that it was time to journey across country to find the head of the Traverspine. Accordingly, we laboriously carried all our stores through the thick woods from lake to lake, every now and then climbing to the top of a hill and then into a tree to see if there were any large lakes which would help us in the right direction. At last we came out on a long narrow lake which had a stream running from it in the direction of the Hamilton. We thought that this was probably the Traverspine, and decided to follow it down.

The descent of this river was far more unpleasant than the ascent of the Kenamu. Day after day we found the river too shallow to ride in the canoes, and we had to wade down, guiding the canoes between the rocks; we all suffered from badly bruised feet from the moving stones on the river bottom. At last we came to a place where the river narrowed down into a series of shoots and falls, and we were forced to do our longest continuous portage, which took us several days; and since it was raining all the time they were the most unpleasant days which we had on the trip. At last, at the end of the portage, we arrived at a point where it was possible to ride in the canoes, through the nerve-racking rapids in which, if the canoes upset, we should lose all the results of our work and all the instruments. However we were soon through the rapids, and then came the last gentle paddle across the flat plain down to Hamilton River. We reached our base just six weeks after we had left, as we had calculated, and

An autumn camp: river still open in the centre

our food came to an end on the day we reached home. During all this time we had had very little fresh meat, just a few duck and geese, but we had been thankful for small mercies in this way. I remember one stew of a duck, a fish hawk, a yellow leg, and two musk rats.

On this journey we had succeeded in mapping the Kenamu from its mouth to a point where it was only a small brook, and also most of the Traverspine River. The mapping was done by compass traverse checked by astronomical positions, the conditions of observation most unpleasant, on account of the mosquitoes. No one who has not been to the sub-arctic can realize what these mosquitoes can be like. They used to surround us in a dense cloud, making it almost impossible to keep our eyes open, and although we covered ourselves in a mixture of butter and tar they did not seem to mind. Luckily, though their bites are most irritating, they are not malarial. Apart from this mapping we had discovered a number of small falls. This water-power will be of use in developing the timber which, in places on these rivers, is very good.

Grand Lake, Snegamook, and Hopedale

We came back to Northwest River Post at the beginning of October, and Leslie left us to return to England. For the next month and a half we were unable to do anything owing to the weather during the change from summer to winter. The rivers and lakes were not yet frozen over, but each night they used to get covered by a thin sheet of ice which melted during the day, but nevertheless made travel by canoe impossible. We attempted a plane-table survey of Grand Lake, which is 40 miles long, quite close to Northwest River, but after ten days of impossible weather we had to give it up. We would climb to the top of a hill at the side of the lake with the plane-table, and then sit down to wait for fine weather so that we could see; on one occasion we spent the night on the top of such a hill, and woke up at two o'clock in the morning to find ourselves covered in snow. After this we gave it up and paddled back to Northwest River in a driving snowstorm.

The days gradually began to get colder, and by the beginning of November we were able to start practice with our skis and snowshoes and dogs. Owing to the difficulty of getting food in Labrador, no one has more dogs than is absolutely necessary, and we consequently found it difficult to get a good team together. A team should really be dogs of the same litter, led by their mother; such a team will work very well together. Unfortunately we were unable to get such a team, and had to content ourselves with dogs picked up from the various settlements along the coast. To begin with they gave us endless trouble, as they were always fighting. Pandemonium would break loose outside our house as two dogs started fighting, the rest of the team would join in, and dogs would come running from every part of Northwest River to the fight. At last, however, by the time we were ready to start they had begun to quiet down.

Our plan was to do a journey into the country to the north of our base: to travel by the old Indian portage routes as far as Seal Lake, and then to turn north-east and find our way out to Hopedale on the Atlantic coast. We had talked about this country with the Indians who had been at Northwest River in the summer. They told us that not far to the north-east of Seal Lake we should find another large lake, which they called Snegamook, and at the easterly

end of this lake that we should find a river running out to the sea. They informed us that on this river they sometimes met Eskimo from Hopedale. We knew that the Eskimo on the coast never travel farther inland than they can get while sitting on their sledges, so we realized that there must be a very easy and level way from this lake out to Hopedale. If so, then it seemed certain that this lake would be an ideal base for an aerial survey of the interior of Labrador. From the Indian's description the lake itself was a long way in the interior, and if this lake had an easy connection with Hopedale so that provisions and equipment could be brought in on motor tractors or by dog team, then no better place could be found for a base. On the maps of Labrador this river and lake are shown in dotted lines and have presumably been drawn in from Indian description, since so far as we could find no traveller had ever visited them. We knew, therefore, that even if the lake proved unsuitable as a base, we should nevertheless be able to do a considerable amount of useful mapping. The first part of this journey (as far as Seal Lake) had been made by Wallace in 1905 on a summer journey, but we felt we ought to be able to improve on his maps, since the route is a series of small portages and lakes, which makes the calculation of distance in the summer extremely inaccurate. The use of a sledge wheel in the winter makes the results much more accurate.

By November 15 all was ready for our start northward. First of all we had to go up Grand Lake, which is 40 miles long and was not yet frozen over, and so we had great difficulty. We piled all our equipment and stores into one canoe until it was precariously low in the water, and Robert Michelin paddled gently up the side of the lake, while Scott and I led the dogs along the bank on chains, which were necessary owing to traps and snares set round the lake. It was a most unpleasant job, since the bank is very steep and the rocks were all coated with ice. Every now and then a slip was the signal for the dogs to start a fight. The journey up the lake took us just two days, and from its head we had to travel another 15 miles up the Naskaupi river, where our work really started. It was here, in 1903, that Wallace and Hubbard made their fatal mistake, which cost Hubbard his life. They had travelled up Grand Lake from Northwest River, and they wished to go as far as lake Mishikamau, where they would be able to get on to the George river and so out to Ungava. They ought to have gone up the Naskaupi, but instead they took a very small stream at the head of Grand Lake and followed it up until they had nearly run out of provisions. It is very difficult to understand how the mistake occurred, since the Naskaupi is the only river of any size which flows into Grand Lake; the other two streams at its head are really only brooks, and not worthy of the name river. If these travellers had either taken a Northwest River trapper with them or got one of the trappers to draw a map of the head of the lake, they could not have gone wrong, for even at the time of Hubbard's visit the trappers knew this part of the country well, and had hunting shacks at the westerly end of Grand Lake.

We found the Naskaupi nearly frozen over, with just a small channel of open water in the centre. A river in this condition is extremely good for travelling, since the hard new ice at the edge of the open water makes an excellent surface to run on. At the beginning of the 15-mile stretch we hoisted our canoe out of the water and put it on a sledge; then, with all three sledges fully loaded, we

started off. The dogs were fresh, and in spite of the enormous load we did the 15 miles very easily in three hours.

Fifteen miles up the Naskaupi there is a small hunter's hut, and here our real work began. Our first objective was a lake called by the Indians Nipishish, which is about 23 miles from the river. On the first day we realized the enormous difference between sledging in open and in wooded country. Our first day up the Naskaupi we ourselves and the dogs were entirely fresh after doing 15 miles in three hours; during the next two days we did a total distance of 5 miles, and at the end of each day both we and the dogs were tired out. To begin with, on leaving the river we had to ascend about 500 feet from the bottom of the valley into the hills, which took us an entire day as we each had to make two journeys, taking a half-load each time. We had with us three sledges, one of them the ordinary Norwegian pattern dog sledge, and the other two flat-bottomed toboggans of a pattern such as most of the Canadian trappers use. In the woods we hauled these sledges ourselves, assisted by two dogs each. This hill from the valley was the most horrid obstacle. In one place it was so steep that we had to attach a rope to the head of each sledge, carry the rope uphill, put it round a tree, and then walk downhill holding the end of the rope, while two more people pulled the sledge up. On a hill as steep as this the dogs were very little use. Even when we reached the top of the hill our troubles were not over, for the country was very hilly and thickly wooded, and to manipulate the sledges among the trees we had each of us to pull all the time with the dogs. Going uphill it was extremely hard work, but downhill was worse, for the sledge would run forward on to our snowshoes and trip us up, and if we got out of the way it would crash into a tree. The greatest distance we were ever able to do in wooded country in one day was 10 miles, and that taxed both us and the dogs to the utmost. After two days of this sort of travelling, we saw that if we were going to complete our journey we must leave a good part of our load behind. Accordingly we made a cache of a great number of things we thought we might manage to do without, and after this we got on a little better. It took us one week to reach Nipishish, and here, for a brief space, we got pleasant open travelling, and were able to run on the lake while the dogs trotted along with the sledges in front of us. Nipishish is about 20 miles long, with a stream flowing out of one corner connecting it with Grand Lake.

From Nipishish we travelled northward, following Indian portage routes from lake to lake, until at last we came to Little Seal Lake, which has been visited by one or two other travellers. The Indians had told us that north of Little Seal Lake we should find lake Snegamook, with a river flowing out to the sea near Hopedale, and we now decided to look for it. Actually we had no difficulty in finding this lake, which was our farthest point westward, and we now started very gradually to turn north-eastward. Unfortunately we were beginning to run short of food, because we had met some Indians who were starving, and had had to give them some of our food and our dog food to help them on their way to Northwest River.

The country here is very much more barren than it is farther south. The trees are smaller and not so close together, and a short distance north of this lake the true Barren Lands begin. In spite of this the woods were still a great hindrance to travel, and we were very glad to get on to a lake again and then on

to the river, which is swift, and owing to the rapids in many places was not yet frozen over. This was great luck, as we were able to travel fast on the newly formed ice at the side of the water. In some of the bad rapids, however, it was open right to the banks, and we had to go through the woods. On the whole, this river is much less rough than most of the rivers in Southern Labrador.

Keeping to the instructions which the Indians had given us, we followed this river down until we had passed three falls, and then began to look out for an old camping-ground on the left bank. We had already taken much longer than we had expected, and by the time we reached the camp we were very short of food. The Indians had told us that when we got to the camp we must just go northward and then follow a lead out through the hills to the sea. Here, however, we were faced with a difficulty. There were three possible leads. One running north, one north-east, and one east. After much discussion we chose the north-easterly lead; it turned out to be the wrong one, but we did not realize it until it was much too late to turn back. We eventually reached the head of a long fiord, where we thought all our troubles would be at an end, and that we should be able to sledge along the new sea-ice to Hopedale. But we were mistaken. We followed the fiord down for about 6 miles, and then to our horror found that the lower part of it had only frozen over the night before and was not nearly strong enough to bear us.

It was evening when we made this discovery, and we made a dreary camp, all of us in very low spirits. By this time both we and the dogs were very hungry, as we had hardly any food left and were only allowing ourselves an extremely small amount each day. I knew that if we could get down the fiord to the sea we should be able to get seals, but until then we could not be certain of anything to eat. We also knew that it would be very difficult to reach Hopedale by going back and across country, and might take us many days. It was only four days before Christmas, when we had hoped to be having a comfortable rest at Hopedale. Added to the fact that we were hungry was the further discomfort of having to sit most of the time in our camp in darkness, as our candles were very nearly finished.

On coming down the fiord we had crossed a snowshoe track, and we decided that next day we would go back and follow it up to find the settlement to which it must lead. If we did not find anything next day we would kill one of our dogs for food; we were, anyhow, determined not to starve on Christmas Day. That night we went to bed in fear and trembling lest it should snow and blot out the track, but next day dawned fine, and we set off early up the fiord and soon got on to the track, evidently the track of a hunter, and we assumed that since he had no sledge with him the settlement could not be far away. We followed the trail for two days until we reached a point where it led out on to a large frozen bay of the sea. It had frozen only recently, and there was no snow on the ice, so there was no track; but we went straight on and, to our joy, just as we were reaching the other side we saw a small Eskimo house. We let out a great shout, and all the dogs started howling, so that before we reached the house there were several of a large Eskimo family standing excitedly outside. They were most kind to us, taking us straight indoors and giving us and our dogs plenty to eat, I only hope we behaved with more self-restraint at the sight of food than our dogs did.

The ice was just strong enough for them to get to Hopedale, and as next day was Christmas Eve they decided to start soon after midnight. The Eskimo sledge went in front, piled high with all their belongings, and on the top of this enormous load sat the entire family, with a large Christmas tree at the back. It took thirteen dogs to pull this sledge. It was a perfect night for a journey, very cold but completely calm, and the whole bay was lit up by a bright aurora. At length night gave place to day, and we fell in with other Eskimo families one by one, all on their way out to Hopedale, and each family with a Christmas tree on their sledge. Our arrival caused a great deal of excitement, and a crowd of shouting Eskimo ran out to meet us, unharnessed our dogs, and towed us on our sledge up to the Hudson's Bay Company's post, where we were received with great kindness by Mr. Clark, the Hudson's Bay Company's manager, and by the Moravian missionaries, all living together in a large house. We arrived just in time to attend a Christmas Eve service for the Eskimo. We spent altogether three days at Hopedale and then started back to Northwest River.

One of the Eskimo at Hopedale told us that he would show us a quick way to the Snegamook river, and we were very glad of this offer, since we knew that this must be the easy path we had felt sure must exist. The way lies straight up to the head of Hopedale Bay and thence straight southerly to the Snegamook river, whence it is an easy journey to the Snegamook lake. The entire journey is over flat country, and motor tractors could be used the whole way from Hopedale to lake Snegamook, which is thus the ideal base for an aerial survey of central Labrador. Stores and equipment can be carried backwards and forwards between Hopedale and the base, and since the whole journey with a good dog team should only take three days, it could be done in a very short time by motor tractor. It seems quite possible that an even more advanced base could be found, since the river continues above this lake and, according to the Indians, there is another large lake farther inland.

The return journey was uneventful; we had bad weather all the time, and travelling was slow. At the head of Grand Lake we met the band of Indians whom we had fed on the outward journey. They were in a very different condition now. They had sold their valuable furs to the Hudson's Bay Company and laid in an enormous supply of food. When we reached them they were just lying in their tents eating, and the tracks round the tents showed that not one of them had moved more than a few hundred yards from the camp during the last week !

The Unknown River and Falls

We got back to Northwest River on January 26, and had hoped that we should be able to have a long rest here after our tiring journey; but we were very behindhand with our programme, and had to start immediate preparations for our next journey, to the Unknown River and the falls. By February 2 we were ready to start.

On our last journey we had used Bovril Dog Pemmican for feeding the dogs, and this had been very satisfactory, the dogs returning in exactly the same condition in which they had left. But this dog pemmican had one or two very minor disadvantages, and, on the advice of a Northwest River dog driver, I determined to take a new kind of food on our next trip He told us we should require

far less of this than we should of dog pemmican, and gave us the exact weight we should require for our seven dogs for six weeks. Unfortunately, this food turned out to be very inferior to the dog pemmican and caused an enormous amount of trouble later on.

We left Northwest River on February 2, and started off on our 250-miles toil up Hamilton River to the Unknown River district. As far as the mouth of that river we had perfect weather, bright sunshine, and about 60° of frost most of the time; but in spite of this it was a difficult journey. In all the rapids there was bad, rough ice to negotiate, and in many places the rapids were so bad that the ice was broken up and there was open water to the banks. I remember a very narrow escape we had in one such place. We had come to a point where the river was open in the centre in a roaring rapid; on the bank along which we were travelling we were faced by a cliff with a steep ice-slope across its face, which we had to traverse or make a detour of several miles round some hills on the bank. We chose the ice-slope. Steps were cut carefully across it; the dogs were led across; and then, one by one, came the sledges. I was standing at the top of the ice-slope and the last sledge was going across; suddenly I heard a shout, and saw to my horror that the sledge had slipped and was hanging out over the edge of the slope, poised above the roaring torrent underneath. Worse than this, the two men who had been pulling it had their hands entangled in the sledge harness and were in danger of being pulled out of their steps. Scott and I rushed down the ice-steps and in a minute we were all four pulling on the rope, and soon had the sledge back into safety.

Owing to such difficulties it took us three weeks to reach the mouth of Unknown River, and the depressing thing was that on this long journey of 250 miles there was no work to be done as the Hamilton has already been mapped.

When we reached the mouth of Unknown River, we saw that this journey was going to take us at least two weeks longer than we had thought, and the food problem became very serious. We had already realized the inefficiency of the new dog food, and, in order to keep them going, we had to give them each day much more than we had allowed for; we saw that we should be forced to kill most of our dogs before the end.

Unknown River in its lower course flows in the bottom of a deep canyon, and is extremely rapid and rough. We had hoped to be able to cross it at its mouth and follow the opposite bank; in this way we should have been able to make constant journeys out to Valley River on our right and so map that as well as Unknown River. Unfortunately we found that it was quite impossible to cross, and so we had to follow its right or southern bank. We first had a very steep ascent to the plateau, so steep that dogs were useless, and we had to haul the sledges up by ropes hand over hand. It took us the entire day to get to the top, and at the end of that time we had only gone forward about a quarter of a mile.

The country near the river was too cut up for travelling, and we had to keep about 4 miles to the south, crossing a great number of streams running north, with many small lakes and several larger. Those large enough to deserve names eventually we have called provisionally lakes A, B, C, etc., and they are thus shown on the map. From a camp about 3 miles north of Lake C we went out

north-east to fix the position of the main river, but we were unable to sledge upon it until we reached a point about 30 miles from its mouth, when we came out on Lake D through which Unknown River runs. At the lower end were large falls (which we shall call later the Upper Falls). It was snowing hard when we first saw them, and if anything this increased the splendour of the scene. The lake abruptly contracts to a small neck and the water pours out over large masses of ice which block the top of the fall. Falling with a roar into a deep canyon below, the river rushes off till lost to sight around a bend, a jumbled mass of ice and water. We should have to follow the river down from here to map it; but before doing this we thought it best to go up to its head, in order to settle the doubtful question of its source. By this time we were very short of food and had already been forced to kill two of our dogs. This slowed us down considerably, and hunger made travelling extremely unpleasant. We saw that if we were to do the journey at all, we should have to do it very quickly. Consequently we made a dump of every unnecessary thing, and even left our sleeping-bags behind. With our lightened loads we set off from Lake D up Unknown River, which was now a placid wide stream with a good sledging surface. Soon we came to a point where it widened out into a large lake E, and here we were faced with a difficulty. From the surface of one of these lakes it is impossible to tell what is an island and what is the mainland, and it is equally difficult to see the point of entrance or exit of any river. Luckily, at the far end of this lake we saw two hills which were free of trees at their summits, and we decided to climb them to get a view over the country.

The day on which we climbed these hills was absolutely perfect, and we were able to see for miles in every direction. First turning west, we could see Unknown River coming into the south-west corner of the lake, and that it flowed from a large expanse of water which ran in a north-westerly direction. This was evidently part of Lake Ossokmanuan, and it was an extraordinary sight, so studded with islands that it was almost impossible to tell whether land or water was predominant. We then turned to the east and immediately saw a river flowing to the north out of the north-western side of the Lake E below us. At first we thought this must be Valley River, as it seemed certain that it must flow into Hamilton River just below the Grand Falls, of which we could see the vapour; and a half-breed later actually declared that it did so. But, since Frissell travelled from his twin falls to the Hamilton River without crossing any large river, it seems certain that Valley River is a small stream which does not rise so far west as this, and that the river we saw must, in spite of appearances, be a branch of Unknown River. A few days later we found a river flowing into Unknown River from the north-west, just above the falls not yet visited by us which we call the Lower Falls, and it seems certain that this must be the second river which we had seen flowing out of Lake E. The country north of Lake E appears therefore to be an island between two branches of Unknown River.

From our hills west of the lake we were able to see the vapour from various falls. To the north-east we could see a large pillar of vapour from Grand Falls. Farther south was another pillar of vapour from the falls which we had first visited on Unknown River (the Upper Falls). Then, to our surprise, we saw two more clouds of vapour: one on the new branch of the Unknown River

Unknown River below Upper Falls

The main Upper Fall

(X Falls) and one on Unknown River (Lower Falls), not far below the falls which we had already visited.

We then realized for the first time that there were two sets of falls on Unknown River near together below Lake D, and that one of these two must be new. Provisionally we had assumed the Upper Falls to be those described by Frissell, but this we found ultimately was a mistake, as will appear later.

So far we had determined that Unknown River came from Lake Ossokmanuan, but that the system was much more complex than we had imagined, and we were now faced with the problem of which set of falls to examine. It was impossible to visit them all owing to food shortage, since by this time we had lost three dogs and were ourselves living on a very thin gruel of flour and water. Added to this the weather was very cold and, owing to lack of nourishment, we suffered considerably from frost-bite. This cold made the theodolite observations at night particularly unpleasant, since it was always necessary to choose an open wind-swept place to work, and to stand for an hour in such a place is no joke, especially as, owing to the cold, our fingers would stick to any metal part of the instruments.

Eventually we decided to investigate the Lower Falls on Unknown River and leave the X Falls for some future occasion. Accordingly we descended Unknown River to the lower end of Lake D and then followed the left or northern bank. About 3 miles below the Upper Falls, which we had visited on our way up the river, we came to a similar pair of Lower Falls.

The main Upper Fall

In appearance these two pairs of falls are very much alike. In each the river is divided into two by a considerable island, and in each the northern branch has on the lip of the falls a large rock and the chasm narrows rapidly below, so that the fall takes the shape of the letter Y.

It becomes an interesting problem to decide which pair of falls had been visited by Frissell and which by an American party, including Mr. Rogers, who came across in the summer of 1928 from the Gulf of St. Lawrence by way of the Romaine, Attikonak, and the Hamilton. They had descended Unknown River until they came to falls which they thought they recognized from Frissell's photographs. What is more, Mr. Frissell has said in a letter that they had taken motion pictures, which he was happy to recognize as the falls he had reported. We were there in winter, and the appearance of the falls is so changed by the immense masses of frozen spray that it is difficult to compare the winter and summer aspects. We are, however, convinced that the falls which Frissell proposed to call the Yale and Grenfell Falls are the Lower Falls, for the following reasons: He had come across country from the Grand Falls and reached the northern bank of Unknown River some little way below the falls. If he had arrived at Upper Falls he would have had to cross the northern branch of Unknown River, which we found coming in below the Upper and Lower Falls; but he makes no mention of it. He says that he could not see the southern component of his falls from any point on the northern bank, which is true of Lower Falls, but not of Upper Falls. Moreover the bearings for the different stretches of the river which he gives agree with our observations at Lower Falls but not at Upper Falls. We conclude then that what we call Lower Falls are the Yale and Grenfell Falls of Frissell. On the other hand it seems impossible that the American party of 1928 can have come down the river by canoe to the

Lower Falls without describing the Upper Falls and making a long portage round them, of which there is no mention. We conclude that they reached only the Upper Falls and must leave unsolved the puzzle how Mr. Frissell could have recognized the Lower Falls in their pictures.

Here then there is a very large potential centre of water-power, since within 16 miles there are at least six falls: the Grand Falls on the Hamilton, two double falls, the Upper and Lower pairs, and one not visited, the X Falls, all on Unknown River. Farther to the south we saw from the hill east of Lake B the vapour of another fall, but were unable to fix its position. It is probably on the upper reaches of the unexplored Elizabeth River. Fortunately this region of the falls has some of the best timber in Labrador, and the development of the water-power may be useful to exploit it. But the complexity of the drainage system of Lake Ossokmanuan, which furnishes the bulk of the water for all six falls, makes it important that any power scheme should be planned as a whole, after careful levelling and gauging.

For the 250 miles return journey down the Hamilton we had only three dogs, so that we were forced to work with one man and one dog to each sledge. Also, owing to food shortage, we had to travel fast and could never allow ourselves more than about four hours' sleep at night. We all hated this part of the journey more than anything we had done in Labrador. There is nothing more tiring than slogging on, day after day, hauling a sledge when one is sleepy and hungry. Added to this it was beginning to get warm and in the middle of the day the snow used to get very soft. In spite of these difficulties we were able to do a distance of about 30 miles each day, so that the journey did not take us long. We got back to Northwest River on April 1, just eight weeks after we had left and two weeks later than we had planned. It is quite certain that we could not have stayed out the extra two weeks if it had not been for the successful hunting of Robert Michelin, who managed to kill a number of porcupines and so keep us and the dogs supplied with a small amount of food during the worst time.

The Coast Journey to the St. Lawrence

We had hoped that our other work would have been finished long before this, so that we could have travelled by sledge across southern Labrador to the Gulf of St. Lawrence, where we should have been able to catch an early boat. In this way we should have been able to map a good deal of unknown country. Unfortunately it was too late in the year to do this journey, as we knew that the southern rivers would start breaking up about April 19. We therefore decided to travel out round the Labrador coast in order to get as far as we could by ice, and then to wait for the first boat. Before this journey it was necessary for us to collect more dogs; so, while Scott was going round some of the near settlements to find them, I went off with one of our remaining dogs to do a compass survey of Grand Lake in order to complete the work which we had started there in the autumn.

Eventually, on April 18 everything was ready for our last journey, and we set out from Northwest River for the last time. Along the coast there are settlements about every 40 miles, so that on this journey it was never necessary

to camp. This meant a large saving in time and also in weight to be carried, since we took no tents. Conditions at the end of April are usually good for travelling, since it thaws during the middle of the day and freezes hard at night. This makes a hard crust on the snow, so that it is possible to travel very fast. It is, however, necessary to start at about three o'clock in the morning so as to get the day's journey over before the snow is too soft.

Before reaching the sea we had a journey of about 130 miles down Lake Melville and the Backway, and we eventually came out on a long stretch of open coast between the settlements of Rigolet and Cartwright. Here the coast-line is very even and not cut up by long fiords and islands as is most of the Labrador coast. As a consequence of this the sea breaks with great force all along the shore and in the winter the spray freezes and forms a high wall of ice with a track like a bob-sleigh run between the shore and the sea. This natural track proved excellent for travelling, and with our loaded sledges we were able to do 45 miles on our last day to Cartwright, which is a typical Labrador coast settlement. Apart from the natives there is only a Hudson's Bay Company Store and a mission. The inhabitants live by fishing all the summer and trapping all the winter.

Although we had been making good distances with our own team we decided at Cartwright to get an extra team in order to try to reach Battle Harbour before the weather became too warm for sledging. We hoped that the mail steamer from Newfoundland would be able to reach Battle Harbour at the beginning of May and that we should be able to leave then. We were able to hire a team at Cartwright, but, as we had not bought it, we were forced to take the owner with us. Unfortunately we were very disappointed with this team, since none of the southern dogs are as good as the true Husky, and we found that, in spite of the extra dogs, we were not able to do longer days than we had been doing with our own team.

Eventually the weather began to get too hot for sledging; we were often wading through slush or water which half covered the sledge and came up to our knees. However, we decided to push on as far as Battle Harbour (where there is a wireless station) before stopping. We were lucky, for the day we reached Battle Harbour the ice on the bays started breaking up. The coast between Cartwright and Battle Harbour is very indented. Most of the time it is impossible to see the open sea, since one is either sledging along inside a fringe of inlands or crossing wide arms of land between the fjords.

Battle Harbour was as far as we could go by dog sledge, but to our disappointment we learnt that the first mail boat would probably not get as far as Battle Harbour on its first trip. There was nothing for it but to travel on. However, for the moment we could not move. Travel by land was out of the question owing to the melting snow, and motor boat travel was not yet possible, owing to the heavy northern drift-ice which packs in against the Labrador coast at this time of year. Fortunately, after about ten days a strong south-westerly wind sprang up. This drove out the drift-ice, and we seized this opportunity to travel by motor boat to a settlement on the Labrador side of the Belle Isle Straits. These straits were blocked with ice, and we could not continue by boat, so we made one last effort by dog team and reached Forteau.

The last part of this journey was exciting as we had to cross Forteau Bay,

where the ice was already broken up into pans which rocked violently as we crossed them, so that we always felt in danger of a cold ducking and the possibility of losing our gear.

Forteau lies just west of Pointe Amour, which is the narrowest part of the Belle Isle Straits, here only about 9 miles wide. At this time of year they are very often blocked for weeks at a time by drift ice, which gets blown in and jams on each side of Pointe Amour. It is almost impossible to cross the straits on the ice, since there is a very strong current which keeps all the ice moving backwards and forwards. The mail man has crossed on two separate occasions, but both times he had narrow escapes.

From Forteau we travelled on by various methods, chiefly walking and carrying our gear, or rowing, until we reached Bonne Espérance, in Canada. Here we settled down to wait for the boat. Many were the disappointments which we suffered from this steamer. On one occasion it got to within 3 miles of the settlement, and was then turned back by the ice and had to return to Quebec. At last, however, the great day arrived and we stepped on board the ice-breaking mail steamer. We stayed on deck late that night to watch Labrador fade slowly away on the horizon while the ship went crashing and shivering through the heavy drift-ice.

NOTE ON NAMES

Unknown River is not satisfactory, but we have written it provisionally because the trappers now know it by that name. Mr. Frissell proposed to call it the Grenfell River, but we have hesitated to follow his suggestion because it seems to be really the principal branch of the Attikonak. For the five lakes which we have lettered A to E it will be desirable to find Indian names, and preferably to give Indian names also to the Upper and Lower Falls and to Falls X, as well as to the new branch of the Unknown River, on which X Falls are situated.

Locally the Ashuanipi is often called the Petitsikapau, because it comes from the lake of that name, and the branch of the Attikonak which comes from Lake Ossokmanuan to Sandgirt Lake is called locally the Seven Islands River, but only because it is on the route from the Grand Falls region across to Seven Islands Post on the Gulf of St. Lawrence. It should be noted also that locally the Hamilton River is always called the Grand, and the name Hamilton would not be recognized by the trappers.

NOTES ON SLEDGING

1. *Motive Power*

Motor tractors are good for taking heavy supplies backwards and forwards between camps, and for journeys where no rough ice or very steep hills are likely. In rough ice motor tractors are too unwieldy and too heavy to manoeuvre successfully. And on thin sea-ice, owing to their weight, they are dangerous.

Horses pull large loads and are easily managed, but they have one great disadvantage for a long sledge journey: the food which has to be carried for them is very bulky and cannot, in an emergency, be used as food for the men. Also in a high wind a wall has to be built for them at night, and this means extra work for the men. Their greatest use on an expedition would be on short journeys when heavy work was required, such as carrying supplies between camps. Horses can

Typical coast settlement. Part of bay ice already melted and drifted out

Single-trace method of dog driving

The fan method

Muskrat Falls on Hamilton River

use snowshoes quite successfully in deep snow, and here they certainly have an advantage over dogs.

It is only necessary to read accounts of the hardships suffered by man-hauling parties, to know that it is a mistake. Instead of getting pleasure and exhilaration from the actual travelling, the men get played out slogging on from morning till night, and their resistance to cold and fatigue gets worn down. Consequently it becomes an enormous effort for them to give their best to their scientific work. In spite of all this effort the records of the best man-hauling journeys show that under average conditions it is not possible to travel more than 12 miles in one day.

Any one who has used sledge dogs for any length of time and has travelled with them in difficult country will agree that for a long journey there is no better method. A team should consist of seven two-year-old dogs of the same litter, led by their mother. These dogs may be driven in three ways: in the fan method, or in pairs on a single trace, or in single file. In the fan method each dog is on a separate trace, and they spread out in the shape of a fan in front of the sledge. This is the safest way on thin sea-ice, since the dogs are spread out widely and there is little danger of their all going through at the same time. On the other hand, there are three great disadvantages to this method. Firstly, the enormous weight of the seven different traces; secondly, the dogs are always getting their traces twisted up, so that as a general rule it is necessary to stop once every hour to unwind them; thirdly, the dogs at each side of the fan are not getting a direct pull on the sledge, and thus a great deal of energy is being wasted. In normal conditions the best method of driving is in pairs on a single trace. If however the snow is very soft and deep, it is better to use the single-file method.

The best type of dog is almost certainly the Eskimo dog or Husky, used in Greenland and all over Arctic Canada and Labrador. They are large dogs, a good specimen weighing as much as 130 lbs. They have a good deal of wolf in them; indeed, the best sledge dog is a direct cross between a wolf and a white man's dog, such as a St. Bernard. A direct cross has much better feet than the average Husky.

The ideal food for a dog team is fresh seal meat and fat, so that for coastal journeys where it is possible to find seals, it is unnecessary to take any food, either for men or dogs. This means a very light load, so that long distances can be covered. On an inland journey where no fresh meat is available, the best food is Bovril Dog Pemmican. Each dog will require 1 lb. of the pemmican every day. It is an extremely good thing to take some seal fat as well, so that the dogs can have a very small piece with their pemmican.

On a long journey there should be one dog team to every man; the loads on each sledge will then be small, and long distances can be covered. A two-man unit can remain out very easily for six weeks without restocking provisions. At the beginning of such a journey the total weight of dog food and man food on each sledge will be about 500 lbs. Since a seven-dog team should not be made to pull more than 700 lbs. to get the best results from it, there is still room for 200 lbs. on each sledge. With this load it should be possible to do 25 miles each day. When this is compared with the 12 miles per day of man-hauling, the advantages are obvious, especially since the men will not be tired out at the end of a day's journey, and both the dogs and men will come back perfectly fit after a six weeks' journey. Every man on a sledge journey should know how to drive dogs, since it is a great mistake to have to rely on dog drivers. The average man can learn to drive dogs quite successfully in a few months, and he will soon know how to get the best out of his team. A good team driven by a good driver on hard snow with a light load can do as much as 100 miles in one day.

2. *Sledges*

The usual arctic sledges are of two types: the Norwegian sledge with wide runners, and the Eskimo sledge with narrow runners. For soft snow and for use in the conditions usually met with on an ice-cap, the wide-runner sledge is best. It bears up well and is extremely pliant and strong in rough ice. Nevertheless the Norwegian pattern has one or two defects which could be remedied. The ends of the runners do not curve up enough, so that in rough ice or deep snow the front will sometimes catch under hummocks of ice. It is also a great disadvantage not to have guiding bars at the back of a sledge. A sledge with bars can easily be swung or guided while moving fast in rough ice or among crevasses. In flat country these bars are unnecessary. A sledge of this type should have interchangeable runners of wood and German silver.

The narrow-runner sledge should always be used on sea-ice. or on any ice which has only a thin covering of snow on it. The runners should be about 1 inch wide and shod with either bone or metal. The runners cut through the snow and the sledge runs on the ice beneath, so that it travels much faster than a wide-runner sledge would on the same surface. This type of sledge is very good on hard wind-blown snow

Possibly the best sledge for varied country would be a combination of the two, with thin runners on top and wide runners underneath, so that the sledge could be turned over to suit the conditions.

The greatest difficulty is always in sledging after a fall of snow at a very low temperature. It is just as if the sledge is being pulled over sand, and there is enormous friction between the runners and the snow. This is very much reduced if the sledge runners are coated with ice, which is done by pouring water over them and letting it freeze. Very little water is needed, so that it is never necessary to stop and melt snow if the traveller uses his ingenuity.

3. *Snowshoes and skis*

On nearly all long journeys it is best to take both. Conditions vary so greatly that one day it will be best to use snowshoes and the next to use skis. For skis the only fastening necessary is a strap over the toes. It is important that they should be kept well waxed, or the friction on dry snow will be very great. Snowshoes should not be of the wide Indian pattern but narrow and rather small. If it is quite certain that there will be no damp snow on the whole journey, then they should be knitted with fine deerskin, otherwise sealskin is better. Snowshoes are absolutely essential on new deep snow, since the dogs will be unable to haul the sledge unless the men walk ahead to make a track. A track made by skis is almost useless.

NOTES ON GEOLOGY AND BOTANY

J. M. SCOTT

For the identifications in the following notes on the geology of the Kenamu River district I am indebted to Mr. C. E. Tilley, of the Sedgwick Museum, Cambridge; and I must also thank Mr. J. S. L. Gilmour for the help he gave me in identifying the principal trees and berries.

The rocks seen in the Kenamu valley were of Laurentian types, including (*a*) highly felspathic augen mica gneiss; (*b*) basic rocks of Gabbroic and anorthosite types, quite coarse grained and containing abundant iridescent Labradorite; (*c*) granite pegmatites with perthetic felspar; (*d*) dykes of doleritic rocks.

One specimen of metamorphic marble with green pyroxene was found, representing the Grenville Series. This is probably similar to marbles described by

Low on the Hamilton. One specimen of more recent rock was seen at the junction of Salmon River with the Kenamu. This appeared as a well-bedded cliff of felspathic grit. It is clearly younger than any other rocks which were seen, and may perhaps be allied to the rocks seen by Low at Sandy Banks on the Hamilton and described by him as Cambrian.

No specimens of economically valuable metallic ore were found; but at one place at the headwaters of the Kenamu the compass needle was deflected as much as 13° from the true, which seems to indicate the presence of magnetic iron in the vicinity.

The coniferous forests of Labrador are 90 per cent. of the black spruce, *Picea nigra*, which grows equally well on the archaean hills and in the more swampy valleys. The tree is used locally for building and for firewood, and its leaves are boiled as a substitute for tea and for brewing a drink called "spruce beer." The silver pine, *Pinus Banksiana*, and the white spruce, *Picea alba*, are larger trees and are fairly common inland, especially in drift soil along the Hamilton and Traverspine rivers. The balsam fir, *Abies balsamia*, is found as far north as the black spruce. It is the Eskimo Christmas tree, and with its branches brush beds are made when camping. The larch, *Larix Americana*, is the tree used by the Indians for making sledges and sometimes for the frames of snowshoes. Other trees which are common, especially on burnt land, are the birch, *Betula papyrifera*, and two species of poplar, *Populus tremuloides* and *P. balsamifera*. Along the banks of the rivers and in swamps *Alnus incana* and about three species of willow are common.

Ground berries form almost the only fresh vegetable food in Labrador. They grow thickly on the burnt land and also in the marshes, and are gathered in the autumn and in the spring as soon as the snow has melted. Round Hamilton Inlet the most common are two species of Vaccinium—*Vaccinium vitis idaea*, known as the red berry; and *V. caespitosum*, the blue berry. The bake apple, *Rubus chamaemorus*, is also common, and another species, *R. stigosus*, is found in clearings in the woods.

NOTES ON SURVEY

The part of Labrador in which we were working consists almost entirely of low rolling hills, covered with trees, which make it extremely difficult to do any accurate ground surveying, since even when you have climbed to the top of a hill it is impossible to see in any direction. The obvious way to map such a country is by aerial survey, and on all our journeys we bore this fact in mind, so that our mapping must be looked upon as an exploratory survey of the country with a view to a future aerial survey. On all our journeys we were mapping by means of compass traverse checked by astronomical positions, and since the only really outstanding features of the country are the rivers and lakes, our traverses were entirely confined to them.

During the summer we got our distances by timing and judging speed. We found that, while ascending a river, after a little practice this method worked out quite accurately against our astronomical positions. It was while descending the bad rapids on the Traverspine that it became very difficult to keep the traverse accurate. We were moving so fast that judgment of speed became difficult, and at many of the bends in the river the water was so rough that it was quite impossible to reach the bank to take a new bearing, so that in some places the bearings had to be taken while in motion in the middle of the river. During the winter we got our distances by a wheel with a revolution-counter fixed to the back of one of the sledges.

Fixing heights was found to be a great difficulty. We took with us a battery of

three aneroids, but owing to the terribly rough travelling these soon became rather inaccurate and unreliable. It was also quite impossible to arrange for any one to keep daily aneroid observations at Northwest River while we were away. Although we arranged this whenever possible, there were many times when no observations were kept, and consequently we had nothing to compare our own readings with. We found that the hills along the rivers were very uniform in height, so that by ascending one every now and then with an aneroid, we were able to judge the height of the intermediate hills with fair accuracy.

The astronomical observations were taken with a $3\frac{1}{4}$-inch micrometer theodolite and two half-chronometer watches. Owing to the very rough country the watches did not keep anything like a regular rate, and in consequence it was only at two points, Northwest River and the western end of Grand Lake, where the G.M.T. was found by "wireless," that longitude could be obtained. For the rest we had to content ourselves with latitude checks on our traverses. Even latitude was difficult to obtain, since it was usually impossible to see north and south stars as well as the east and west stars necessary for finding the time required in the more accurate computation. Most of our latitudes were from altitudes of *Polaris* or the sun.

NOTES ON WEATHER

Throughout our stay in Labrador we kept a daily record of the weather, and for most of the time temperature and pressure records. Unfortunately, owing to breakage and loss of instruments on several occasions we were unable to read the temperature or pressure for a considerable time.

The prevailing wind at Northwest River is the north-west wind, and so long as this wind blows there is seldom snow or rain. There are very seldom perfectly calm days with no wind, but there was nearly always a strong breeze and in the autumn usually very strong gales.

On most clear nights there was a bright aurora, and we noticed that there were finer displays of this during the latter part of the summer than during the winter.

SUMMARY OF WEATHER

	Cloudless	*Clouds and sun*	*Overcast*	*Rain or snow*
1928 Aug.	6 days	9 days	5 days	11 days
Sept.	8	7	4	11
Oct.	4	10	7	10
Nov.	8	6	9	7
Dec.	7	10	4	10
1929 Jan.	5	8	4	14
Feb.	20	4	1	3
Mar.	8	8	4	11
Apr.	15	4	2	9

	Morning temperatures			*Evening temperatures*		
	Lowest	*Highest*	*Average*	*Lowest*	*Highest*	*Average*
1928 Aug. ..	—	—	—	—	—	—
Sept. ..	36° F.	60° F.	44° F.	37° F.	69° F.	49° F.
Oct. ..	23	43	34	24	44	35
Nov. ..	−10	35	23	− 4	34	24
Dec. ..	−28	32	6	−18	32	10
1929 Jan. ..	—	—	—	—	—	—
Feb. ..	−39	18	−15	−24	20	− 3
Mar ..	−29	20	− 1	−30	23	− 4
Apr. ..	—	—	—	—	—	—

The figures for March are for the first fifteen days only.

DISCUSSION

Before the paper the PRESIDENT (Colonel Sir CHARLES CLOSE) said: It is not necessary for me to introduce the lecturer to-night. I was going to describe him as our old friend, but perhaps that might be a little inappropriate. At any rate, he is a friend of ours and has appeared on this platform at two previous meetings of the Society. In February 1928 he gave us a lecture on the expedition which he organized and led to Edge Island. We thought that such an excellent example of geographical effort that he was awarded the Cuthbert Peek Grant by the Society. He tried to leave for Labrador before the presentation could be made, but was not successful and, as a fact, I had the pleasure of presenting the Award to him in June 1928. Then he went to Labrador and with two objects in view: one to acquire some knowledge of the falls to the south of the Grand Falls, and another to discover something about the diplomatic watershed. He was not successful in discovering much about the watershed, but he has found out a great deal about the falls. He was accompanied in his expedition by Mr. Leslie and Mr. Scott, whom we shall hope to hear later in the evening. Meanwhile I will ask Mr. Watkins if he will describe his adventurous expedition, and we shall all learn something about a country which—I speak for myself—we probably at present know very little.

Mr. Watkins then read the paper printed above, and a discussion followed.

Mr. J. M. SCOTT: I hoped at least Watkins would leave me something interesting to say; but he has left nothing except geology and botany, neither of which I know much about. As you have no doubt gathered from what Watkins said, the whole of that part of Labrador over which we travelled is covered with trees and other vegetation, and in the winter there is an additional covering of snow; so that it is on comparatively rare occasions that one sees rock exposures. However, in the summer, journeying up the Kenamu river we were able to collect a number of geological specimens which I brought back, and Mr. Tilley, of the Sedgwick Museum, Cambridge, has identified them for me; while in regard to botanical specimens I was lucky to have the assistance of my friend Mr. Gilmour at the Botanical Museum. Our specimens came from the country through which the Kenamu flows, which is similar to that of the Hamilton, which Low's geological survey showed is Archaean, as, in fact, is pretty well the whole of Labrador. Our rocks were chiefly of the Laurentian series. The basic rocks contained a great deal of Labradorite, which is a very pretty blue iridescent mineral. We also found one sample of metamorphic marble of the Grenville series, and one post-Archaean rock, a felspathic grit.

All the rivers are interesting because, though they have the typical slow lower reaches and the typical rapids through the mountains, they do not come from springs on the mountain-sides, but from the most complicated series of lakes and marshes which seems fairly general over the whole of the interior plateau of Labrador, and which is only broken up by few and solitary high hills such as that we climbed at the top of the Unknown River, and from which we could see so far. These lakes are connected together by meandering streams. It is hard to tell which way they are flowing, and consequently hard to tell just where the Height of Land is.

About the much-vaunted mineral wealth of Labrador I am afraid I can say nothing, because we did not find any. I was taught how to do field analysis of minerals before we started by Mr. Macgrigor, but I am sorry to say we had no opportunity of using the knowledge. That does not say much, because we really had no time to do proper prospecting, and that discloses our inability to solve one rather interesting problem. When we were right up at the top of the Kenamu

we were taking both forward bearings to the place we were going to, and back bearings to the place we had come from, and the difference varied by as much as 15° from 180°. That means that somewhere to one side of us there was a mass of magnetic mineral, probably iron, deflecting the compass. But the hills were covered with vegetation; we were short of food, and were unable to find any specimen which would give a clue as to why this was happening.

The forests of Labrador consist 90 per cent. of the black spruce (*Picea nigra*), which is a strange little hardy tree, growing equally well on Archaean hillsides and in the swampy valleys. The natives use it for firewood and to build their houses with, while the leaves are boiled to make spruce tea. We made the tea once or twice and found it quite good: it probably has anti-scorbutic properties. The natives also brew a strange drink which they call spruce beer, the latter word being rather a euphemism, because the brew results in a somewhat anaemic sort of ginger-ale. Other trees are white spruce (*Picea alba*) and *Pinus Banksiana*, and these we found on the drift soil on the Hamilton and at the top of the Traverspine. White spruce does not make good tea; I used it once and was not at all popular! A balsam fir (*Abies balsamia*) is found associated with the black spruce. It has all its branches arranged in one plane parallel with the ground, and for this reason it is used as brush strewed on the floor; when it is laid carefully, all the branches put down in one direction, it really makes a very comfortable bed. It is also the tree the Eskimo use for Christmas trees. The larch (*Larix Americana*), which the natives call the juniper, is the tree the Indians use to make their sledges: they cut down a dead tree, hew it into a rough shape with an axe, and smooth it with what they call a crooked knife, made by themselves from files which they buy from the Hudson's Bay Company. The knife is used by pulling towards the worker along the log instead of in the usual way.

Forest fires are common in Labrador and have been attributed to carelessness on the part of trappers who leave fires burning, and also to lightning after long periods of drought. Whatever the reason, they effectively kill off any vegetation in their way, after which the spruces do not seem to be the first trees to grow up again. Trees such as the silver birch (*Betula papyrifera*) and a poplar (*Populus tremuloides*) spring up very thickly and make a forest through which it is very hard to pass, especially when one is carrying a plane-table. Along the river-banks willows and alders grow thickly and make it hard to drag a canoe, because it is necessary to hold the line high above one's head to prevent it fouling the bushes.

The various berries are interesting because they form almost the only vegetable food which the inhabitants have. They are picked in the spring after the snow has left them, and in the autumn by parties which go out and camp. The most delicious and, fortunately, the most common, are *Vaccinium caespitosum*, which the natives call the blue berry; and *Vaccinium vitis idaea*, the red berry which they use when they have no salt. *Rubus chamaemorus*, the Bake Apple, is also common. They keep the berries frozen in an outhouse and bring them in when they want a meal.

Watkins has spoken of the personnel of the expedition; perhaps another point of view would be interesting. We really got on very well with Robert Michelin, the trapper, who accompanied us. Besides helping us he acted as our spiritual guide. I remember the leader of the expedition was "told off" once for singing on Sunday, and we were sternly discouraged from mending our trousers on that day. I am certain he never thought we were anything but fools to spend a year of our lives travelling about Labrador for no apparent reason, and I am afraid I agreed with him on that point on one or two occasions. I do not think Leslie did. Leslie helped me with the geology, such as it was, and always seemed to find a certain amount of pleasure in the fundamental unpleasantness of nature. I

remember even when we returned to Northwest River after our Grand River trip he preferred sleeping among the stores instead of in a bed that had been offered us. I cannot on this occasion say why! Watkins was certainly never troubled by the conditions; he was always perfectly happy. He has been good enough to say we got on very well together. We did, in spite of the fact that, as he said, we always argued. That was due to his adaptability and to the fact that there was no reason why we should quarrel; but I think the real reason why he thought I was a comparatively suitable companion was that I do not take any sugar! He does, and he thought he was perfectly justified in carrying a sugar ration for every man. He did not worry what the hardships were so long as the chocolate lasted and his sugar had not melted away.

Mr. L. A. D. LESLIE: First of all I have to remind you that I was on only the first part of the expedition. When the weather started to get cold in Labrador I left the country as soon as I possibly could. When we were at the Hudson's Bay Company post at Northwest River a number of Indians were living there in their summer encampments. The Indians inhabiting the Labrador Peninsula are estimated to number about 4000, divided into two tribes: in the north the Naskaupis, and to the south, in the more wooded part, the Montagnais. Some of the Naskaupis inhabit the barren lands, and we did not meet with any of them during the expedition. The Montagnais are believed to have been driven north about the time the French first occupied Canada by the more warlike Iroquois. The word "Montagnais" is derived from the French; the real native name for the tribe is the Tshe-tsi-uetin-uerno. Both these tribes belong to the Algonquin branch of the North American Indian race, and are allied to the Ojibways and the Crees.

The most striking characteristic of these Indians is that they still live the primitive hunting existence of their ancestors. During the whole year, except for a few weeks when they camp at the Hudson's Bay Company's post and trade their furs, their time is spent living a nomadic existence in tents in the vast interior of the country which forms their home, and which is still divided up into hunting-grounds which are handed down from generation to generation, each family or sect sticking more or less to its own hereditary ground. They live in tents all through the winter, and nowhere, except right down south on the banks of the St. Lawrence, do they live in houses. They live mostly on what the country provides: caribou, bear, rabbit, partridge, and fish. As a matter of fact, at times, they are very lucky if they get anything at all, because the rabbits in certain districts often die out completely, and caribou one might not meet for months on end.

The blood of these Indians is still practically pure, and they retain their own language. Among the Indians of Northwest River—about eighty altogether—only three could speak any English, and only one who could speak with any fluency; the English of the other two consisting of a series of grunts with an occasional "Yes" or "No." Their features appeared to me to be very Asiatic, of the Tibeto-Burman group. In fact, I could have picked out many who exactly resembled certain types I have seen in Upper Burma. Only once did I see the traditional aquiline features of the race. For the most part, they were broad-nosed and rather flat-nosed. The colour was of about the same darkness as prevails in Northern India; to be more exact, about the same as that of an average Punjabi Mussulman. In the way of physique none were big or muscular. Occasionally one saw a 6-foot Indian, but for the most part they are small and wiry, but immensely strong. A squaw is warranted to be able to carry a load of 200 lbs. on her back across a portage. In Labrador the women are made to work. When the man comes in from hunting he lies down in a corner; the woman does the rest.

Their clothing consists of European garments which they pick up at the Hudson's Bay Company's store: trousers, shirts, and so on. The men still wear their hair pretty long, almost halfway to their shoulders.

In nature the Indians are not at all surly or aggressive; they are a very simple-minded and child-like people, rather shy of outsiders, though always willing to share a laugh with a stranger even if they do not know enough language to share conversation. Their religion is Roman Catholic; and as they see their spiritual advisers for only a few days every year when a priest visits them at Northwest River in the summer, their ideas are perhaps a little vague, and some of the older pagan beliefs still persist and are mixed up with their present beliefs. For instance, I am told that one may still in the interior find the bones of caribou and other animals hung up in the trees, which is an old form of pagan offering to bring good hunting. Some of the Indians are also thought to believe in the Windigo, a most fearful man about 7 feet high, covered with hair, who jumps out from behind a tree on an unsuspecting hunter. Strangely enough, this same belief persists in Alaska. I was told not long ago by a trapper visiting this country from Alaska that all the Indians where he was living also had this strange superstition.

Their arts and crafts are practically confined to the making of canoes and snowshoes. They make their canoes very successfully indeed with no other instrument than a kind of curved knife. The squaws do beadwork in a small way. Musical accomplishments are confined to beating a skin drum. When they do so, the young bucks all hop round in a circle grunting like bears—a really most extraordinary sight!

From what I have heard and read of the Naskaupis, they seem to be far more primitive than the Montagnais. For sustenance and winter clothing they depend almost entirely on the big migrating herds of caribou; if they miss a herd it means starvation. Some are still absolutely heathen. They use the bow and arrow, and are probably the most primitive type of savage still to be found in the North American Continent.

The PRESIDENT: We are very glad to have with us to-night Lord Morris, formerly Prime Minister of Newfoundland. We shall be glad if he will say a few words on the subject of the exploration of Labrador.

Lord MORRIS: To-night we have had an illustration of what can be accomplished in very difficult circumstances and in practically unknown country. What struck me was the entire unconsciousness of the three explorers that they had done anything at all out of the ordinary. That is the way with all good pioneers. With the exception of the last ten years, I have lived my life in Newfoundland, and although I had the advantage of visiting a small portion of the Labrador coast on one occasion and seeing some of the fine work that has been done on that coast and on the north-east coast of Newfoundland by Sir Wilfred Grenfell, I cannot claim to have any real knowledge of the interior of the country. It is a fact that up to the present time it has not been mapped or explored, and we really know very little of it except what we have learned from the great Canadian geologist Low and a great deal of information with regard to the coast for which we have to thank Sir Wilfred. There are only about 3000 permanent residents on the Labrador coast, but in the old days, when Dr. Grenfell, as he then was, came first, between 30,000 and 40,000 Newfoundlanders went down to the Labrador coast in June and remained until September, catching cod all along the coast.

Under the judgment of the Privy Council, there being a dispute between Canada and Newfoundland in relation to this Labrador territory, Newfoundland was awarded the country up to the dividing line known as the Height of Land,

and all the water that comes down to the Atlantic coast covers Newfoundland territory. It is sometimes asked, Why is it that Newfoundland, who owns this great peninsula, at least to the watershed, does not do more to develop it? Of course it is not a very easy matter, as you can understand, for the Newfoundland Government to find the money that would be necessary adequately to survey and explore that vast region. We have to do it very gradually. I want to make the point clear that there is no reflection on the people of Newfoundland or the Newfoundland Government, because when you realize that in Newfoundland to-day there is only a population of something like 260,000, and when you know that that small population has to contribute towards keeping the country abreast of the world in the matter of public utilities, lighthouses, roads and bridges, schools, courts of justice, Marconi stations, and all the rest, then you will understand what they have accomplished. In other words, if to-morrow there were two million people living in Newfoundland they would not have to expend one more dollar for any of these public utilities.

Sir WILFRED GRENFELL: I am delighted to be here to-night because you are discussing Labrador. Very few ever do, with any knowledge of it. The great point that I got out of what Mr. Watkins said was his optimism. Forty years ago I was the only optimist in Labrador. Now we are coming into our own. We have had a number of expeditions, mostly those we have made ourselves. The first was an American expedition in the year I arrived there. The explorers went up the Hamilton and left their tent and canoes below the Grand Falls. Unfortunately, they left their fire burning, and so returned to find their supplies, their boat, and their tent destroyed. They came down to us floating on logs. The next was also an American expedition by a lawyer and a newspaper man, Wallace and Hubbard. Hubbard starved to death. Wallace would have starved but for one of the Labrador boys from Northwest River, who came and got supplies after he discovered Wallace alive and Hubbard dead. Varick Frissell has been in twice; then Eugene Delano, also of Yale; and then Thomas, a Carolinian from Ashville, also went in and took photographs of two other falls; I think with Mr. Watkins that probably those are what his Cambridge party saw this year. Another man who has done a great deal of work in the interior of Labrador is Dr. William Cabot, who is the best authority on the Indians; he speaks the language and is going in again. He has written an interesting book on the Indians of Labrador.

This year I saw a number of Indians who were very badly off in the north. I reported it to the Newfoundland Government, because the Government have inherited the whole country and with it this responsibility. The Indians were starving. I had about seventy of them on board my boat at Davis Inlet (Ukasiksalik) in the north, and a more hungry, naked, and sick crowd I never saw. Fortunately, the caribou are back in some numbers, but the Indians destroyed a great number needlessly last spring.

Looking at life in Labrador from the point of view of those who live there, I think it is a very valuable country. The timber is most extensive and will be valuable, and there are great sources of power. I wish Mr. Watkins had said to you what he said to me when we came in, as to opening up the country by means of aeroplanes. We have had quite a few visitors in that way. An Australian, Major Cotton, offered to help, and he visited all our stations during two winters and appeared to find no trouble in landing on the snow or the standing ice of the fjords by the hospitals. Last winter Captain Cauldwell came and brought with him an Irish nurse. She said her only trouble was that he would fly so close to the tops of the hills. I am sorry to say he has since lost his life near Montreal through hitting a wire. I am, however, sure the aeroplane is one of the solutions of our difficulties, as our short-wave wireless broadcasters are already.

What can Labrador do for this country? A great deal. One of the speakers stressed the value of the berries. I was speaking to one of the Hudson's Bay Company men this afternoon, and I find that a very promising trade is already being done with cranberries and bilberries, thousands of barrels of which are being exported from Newfoundland. In connection with a branch of our own work we have down every year a professor from one of the big agricultural colleges, and we are experimenting with these berries; they can be enlarged enormously. One species, a whortleberry, can be cultivated as large as a grape. The trouble is that most of us are inclined to look at a thing as it is: we do not see any good in it at present; therefore it never will be any good. Labrador is going to give Great Britain a good meat supply. At one time I had 300 reindeer; I doubled them in three years, and in six years I had 1500. Then the war came and I did not get the backing I needed—or the protection for the animals, and I removed those I caught on my return to Anticosti.

The Canadian Government has undertaken to give me back a thousand if the increase of those in Anticosti justifies it as soon as we start the herds again. There is no doubt in my mind that it will be possible to have as many as two million on the Labrador coast. It is not necessary to find food for them, and they can be put on the market for three dollars. Labrador is about 2000 miles from England, and it is possible to ship far later than from Alaska, where they began with twelve reindeer brought over by my friend Sheldon Jackson. Everybody said he was foolish, but to-day there are one million in Alaska; one herd consists of 100,000, and many natives have as many as 500 apiece. Reindeer meat is very much like mutton, and there is no doubt it can be put on the market at a very low rate. Several companies are anxious to get concessions, and the Newfoundland Government is considering the question. The Marketing Board of the Empire are considering a very much-needed animal research breeding sub-station in Labrador.

I thank Mr. Watkins for being an optimist, because he is right. It is a country which has very much to offer.

The PRESIDENT: We have always had the perfectly sound idea that exploration in Labrador is a difficult and serious matter, which requires much preparation, and we know that that exploration involves hardship which has been very lightly touched upon by the lecturer, and by Mr. Scott and by Mr. Leslie. We all appreciate that they have gone through a great deal in order to be able to give us this lecture. We as a Society did our best to support the expedition, and we think that they have thoroughly justified the confidence which we placed in them. We congratulate Mr. Watkins, Mr. Scott and Mr. Leslie on what they have done, and we thank Mr. Watkins for his lecture and thank him and his companions for the explorations that they have carried out in Labrador.

FORESTS AND PLANTS OF THE ANGLO-EGYPTIAN SUDAN: *A paper read at the Evening Meeting of the Society on 13 January 1930, by*

DR. T. F. CHIPP, Assistant Director Royal Gardens, Kew

THE Anglo-Egyptian Sudan is broadly V-shaped, with its point about the centre of the continent and its top near the parallel 22° north. Except in the north-east along the Red Sea, its boundaries are not along any natural lines, but are purely for political convenience.

In studying the vegetation of the Sudan, therefore, one must first realize that the country is no natural entity, but is only a part of a great natural region. To understand this vegetation we must consider for a moment the division of this part of Africa into these natural regions.

The Controlling Factors

The recognition of a natural region depends on a study of the factors controlling the distribution and nature of the vegetation, and also a study of the individuals which comprise the units of vegetation, their occurrence, associations, and distribution. In the present discussion it will suffice if the first of these categories only is considered.

The part of Africa with which we are concerned is that vast region in the northern tropics intersected by the river systems of the Niger, Congo, and Nile and crossed by interrupted chains of mountain masses. The area of this part of the continent is so great in proportion to the height and size of these mountains that they do not affect the climate of this region as a whole, but rather create local climates in their immediate vicinities. The natural factor which exercises general control over the vegetation is therefore the climate over the area as a whole, whilst local modifications are due to the waterways and the basins and lakes to which they contribute, and to the mountain masses where they attain sufficient importance.

First with regard to the factor which controls the vegetation generally, namely the climate. The situation of our region is a battle-ground between the north-east trade winds and those from the south-east, which occur here in a deflected form as the south-west monsoon from the Gulf of Guinea. The north-east trades are the dry desiccating winds which have come across the continent of Asia and approach over the deserts of northern Africa; the south-west monsoon is the life-giving source of rain.

Thus, in a general sense, we find to the south-west of the region at the incidence of the monsoon the most luxuriant development of plant-life, while to the north and north-east is the barren desert, a country to which the rains of the monsoon are unable to penetrate, and which is always subject to the north-east winds. Between these two extremes there is a definite series of belts of vegetation in progressive or retrogressive sequence of development, according to the direction in which the region is traversed.

As the Gulf of Guinea plays such an all-important part, and the vegetation is developed in belts circling round it, the region, which includes that of the Anglo-Sudan, may conveniently be known as the West African Botanical Region. This region is bounded in its turn by other regions under the control

of different climatic units. The northern part of the continent comes into the Mediterranean region; on the east the Abyssinian plateau is a self-contained unit with almost sharp natural boundaries. Farther south the chain of the great lakes, in a general way, marks the limit between our West African Region and that which is controlled by East African influences. To the south the change takes place about the Katanga Plateau. No general study of these neighbouring regions on the east and south has yet been made, and it is inadvisable in our present state of knowledge to attempt anything more than a general indication of the boundaries of the West African Region in these directions.

It is essential to emphasize the fact that it is the climatic complex as a whole which exercises a controlling influence on vegetation. In Tropical Africa, however, there are very few stations where complete meteorological records are taken, while rainfall records are obtainable for stations scattered over the continent. As a matter of present convenience, therefore, the rainfall factor has been taken as an index of the climate, in explanation of the influence exerted by the climate as a whole.

In passing it should be mentioned that the meteorological records as generally obtained do not give a representation of the state in which the vegetation occurs. The instruments are nearly always in places from which the natural vegetation has been removed. Nevertheless these are the only records obtainable, and when used to demonstrate comparative rather than actual differences they may serve a useful purpose.

The other controlling factors may be referred to more briefly. Within the tropical and equatorial regions the climate is sufficiently intense to modify the soil, so that soils, in a very general sense, may be considered as climatic types instead of being grouped according to the rock matrix from which they have been derived. It is, therefore, in its physical capacity of holding water that the soil has chiefly to be considered. This influence is manifest wherever a river, watercourse, oasis, or underground supply of water is available for plant-life, and consequently one finds the fringing forests, vegetation along watercourses, drainage lines, etc., of a different type and more luxurious than that supported by the surrounding country. Again, the waterlogged soil of the big basins provides enormous swamps which are found in tropical Africa in the southern part of the Sudan, and around the big lakes such as Chad and the Victoria Nyanza.

These instances refer to fresh-water conditions. The same factor is in operation, however, along the coast and at the big river deltas, where the sea-water in suitable conditions maintains the mangrove swamps. The largest area of mangrove in northern tropical Africa is that at the mouth of the Niger. This type is represented in the Anglo-Egyptian Sudan only along the Red Sea.

The last of the natural factors controlling the distribution and nature of the vegetation to which it is necessary to refer, is the Physiographic Factor. It works partly through the two factors already discussed, but it depends on land elevation, relief, aspect, slope, water currents, etc. Its effect is seen in the montane vegetation of the tropical African mountains and plateaux which is found throughout east and west tropical Africa wherever suitable conditions obtain.

Before leaving this side of the discussion reference should be made to yet another factor, which, owing to its operation on an extensive scale and over a long period of time, has come to be regarded as a natural factor, namely the influence of man. In connection with his shifting cultivation, his pasturing, and his method of hunting, he sets fire to vegetation and causes modification in its constitution and development over immense areas. Even where the vegetation is too sparse to burn, his influence is seen in the destruction caused by the grazing of his camels, herds, and flocks. The requirements of large centres of population, which arise and disappear in the course of time, are responsible for the complete devastation of large areas. It is a matter for consideration whether sufficient significance has been given to the destruction and modification by man of the natural vegetation of tropical Africa.

To summarize the above discussion: there is the climatic factor which exercises general control over the distribution and character of the vegetation of the West African Region, as is seen in the belts of vegetation diminishing in development the farther they are from the Gulf of Guinea; there are within this Region isolated developments of other types of vegetation dependent respectively on the edaphic factor or the presence of an elevated land mass. Through all and over all the influence of man is evident in the modification or disappearance of the natural vegetation.

The Chief Types of Vegetation

With this idea of the controlling factors of the West African Botanical Region we may pass to a consideration of the chief resultant types of vegetation.

The climatic control is most favourable to the development of vegetation around the Gulf of Guinea, near the incidence of the south-west monsoon, and under the equatorial cloud belt. Here occurs the great Closed Forest of the Congo and the Cameroons, which stretches as a thin ribbon, interrupted in places, along the coastal belt of Upper Guinea as far as Sierra Leone. In the centre of Africa its northern boundary is about the parallel 5° north, whilst eastwards it stretches generally to the borders of the Belgian Congo, with tongues of forest protruding into the eastern part of the continent. In the south it covers the basin of the Congo and its tributaries up to the slopes of the Katanga plateau. This is the Closed Forest of massive lianes and giant trees whose crowns of thick foliage are so densely interlaced as almost to shut out the rays of the overhead sun. It is in stable equilibrium, and destruction can only be effected by felling and clearing, and even this results in a return to forest directly the hand of man is removed.

The next belt of vegetation, circling the Closed Forest, is of a different nature, and is a scene of conflict between Forest and Grass-woodland vegetation. Trees stand isolated or are grouped in patches of woodland with a comparatively open canopy, whilst tall grasses and herbs stretch continuously over the countryside. From a distance the view is that of rolling park-like country, but the traveller finds the grasses and herbs of a height that shuts out all view once he is amongst them, and nothing protects him from the rays of the overhead sun. The trees nearly always show the effect of fire in their stunted, gnarled, and twisted branches and trunks, and what appear to be seedlings

with a tuft of leaves showing above ground prove to be thick woody rootstocks many years old, well established below ground and able to withstand the fires. Left to itself the forest would undoubtedly hold its own over a large part of the area, but by the help afforded by man in his practice of shifting cultivation, inflammable material, in the form of grasses and other herbaceous vegetation, has become established, and by the aid of annual fires the forest is checked, driven back, and regeneration prevented. This belt, which extends very approximately from 8° to 13° N. in the west, stretches with the same width

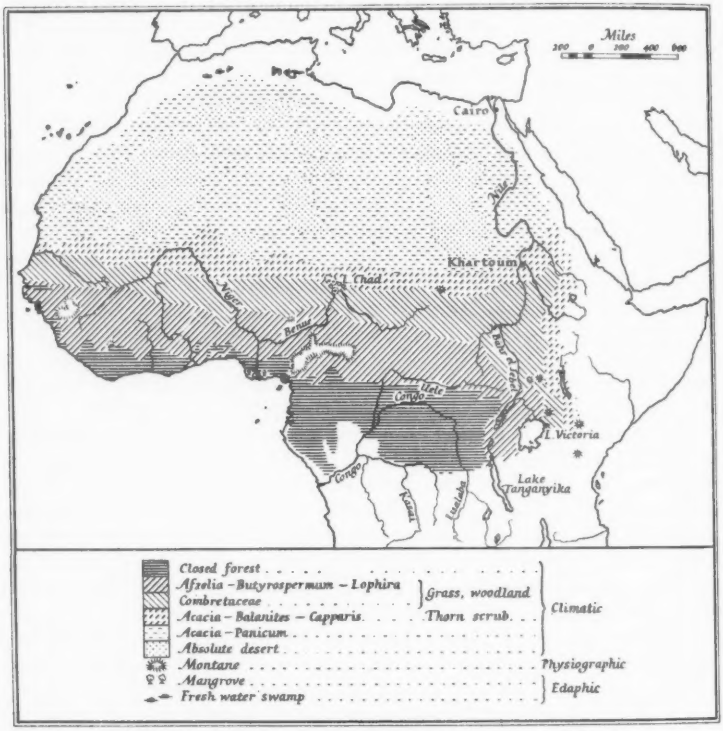


Fig. 1. Vegetation belts of West African Botanical Region

around the north of the Closed Forest, and bends southwards skirting the great swamps of the southern Sudan.

The species to be found in this area are a mixture of those left behind in the retreat of the forest, which have been able to withstand the rigours of this new existence, with invaders from a more arid type of vegetation following up the grasses and herbs which have travelled faster and early taken possession of the ground. Typical trees of this belt are species of *Afzelia*, the Shea Butter Tree (*Butyrospermum*), and the Red Ironwood (*Lophira*).

The transition to the next and more arid encircling belt, where trees of the

family *Combretaceae* (Durut, Subakh, Sahara, and Habil) are conspicuous, is gradual, for the physiognomy and composition of the vegetation are not abruptly changed. The trees are smaller; the herbs not so luxuriant. Laterite-capped ridges, a noticeable feature in the last belt, are still frequently seen. The effect of the fires over a vegetation struggling to maintain itself under a much diminished rainfall and in close proximity to the heated surfaces of the great desert, is shown in the number of pole-like trees, and tufted bushes which never get the opportunity to develop to the tree stage. This is a dreary country and perennial streams are scarce, so that the agriculturist is more restricted in his sphere, whilst the hunter and herdsman roam over vast stretches. The belt which crosses Africa to the south of Lake Chad extends through southern Darfur and Kordofan and envelops the big swamps of the southern provinces of the Sudan.

A more open herbaceous vegetation, scanty and tufted, is to be found in the next belt, the Thorn Scrub, where sand and black cotton soil support a tree growth different in appearance and composition. Typically this is the first of the belts in which the Acacias commonly occur with other trees such as the Heglig (*Balanites aegyptiaca* Del.) and the Hekkabit (*Capparis*). These, generally bush-like and only occasionally with the trunk of a standard, are isolated, and there is no tendency to form any patches of woodland or groves except along the watercourses. Economically this type is important, for it is the belt from which comes the gum arabic of commerce, one of the main exports of the Sudan. The belt passes to the north of lake Chad through Darfur and Kordofan, and then under the influence of the Abyssinian plateau trends northwards through Kassala.

Finally there are the vast stretches of the desert itself, not devoid of vegetation except in limited areas, but possessing only occasional bushes and shrubs, tufted plants and grasses, or a carpet of evanescent herbs after the occasional showers. Here the *Acacia* is the dominant bush, and connections are to be found between this flora and that of Arabia and the Indian deserts.

Although the line between the Closed Forest and the surrounding Grass woodland type of vegetation is sharply drawn, the other types grade generally into each other through a transition area, although in some cases the change may be distinctly marked over a limited area. There is, however, always to be found in the more arid country more luxuriant vegetation of the southern type lingering on in the form of tongues or galleries of forest or tree growth along the watercourses. These fringing forests, as they are termed, are a marked feature of the African vegetation and are of great importance in preserving the perennial flow of water, though this point is all too little realized by the local peoples, who are attracted to make their farms in them and consequently cause their destruction.

With this brief sketch of the main factors controlling the distribution of vegetation in the West African Region, and the main types resulting from the climatic influence, we are in a position to consider the vegetation of the Anglo-Egyptian Sudan. The Edaphic and Physiographic controls may be studied as they are encountered in our survey of the country.

The Vegetation of the Anglo-Egyptian Sudan. 1. Climatic Types

Some index of the climate of the Sudan is provided by the rainfall curves (see Fig. 2). Their general trend after they reach the middle of the country, is sharply northwards around the Abyssinian Plateau, but the curves for 700 mm.

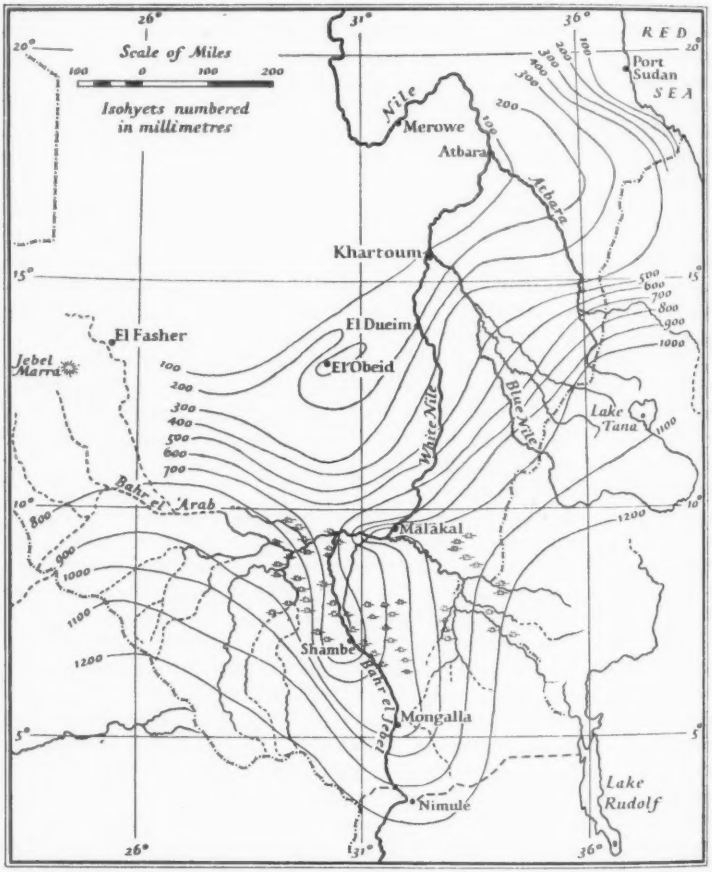


Fig. 2. Mean Annual Rainfall of the Sudan, 1905–1909, from diagram in 'Gum Arabic, with special reference to its production in the Sudan,' 1926, by H. S. Blunt, based upon map compiled by Sudan Irrigation Department.

p.a. upwards first bend southwards around the Nile–Congo watershed, following the Bahr-el-Jebel course for a while before crossing to the east and trending sharply northwards.

The behaviour of these curves is reflected in the distribution of the vegeta-

tion. The Desert and Thorn Scrub belts cross the country and on the eastern side trend northwards. The Combretaceous Grass-woodland belt spreads out markedly southwards and then contracts and turns northwards; the more southern Grass-woodland belt passes down the west side of the southern provinces almost over the southern border and then along the Uganda frontier and then northwards.

The following account, which is admittedly a record from first impressions, is compiled from notes made on a journey which lasted from November 1928 to March 1929. The route was from Wadi Halfa to Khartoum, with a subsequent visit to Dongola Province by rail from Abu Hamed to Kareima and thence by steamer to Mansu Koti. From Khartoum we went up the Blue Nile nearly to Roseires in The Fung. After returning to Khartoum we went south by the White Nile to Kosti, thence to El Obeid by train. A motor car was used as far as El Nahud in Kordofan, and after returning via Abu Zabad to El Obeid, a southern route was taken through the Nuba Mountains to Tonga, on the White Nile. The journey to Rejaf was made by steamer; thence an excursion through the west of Mongalla Province was made by motor car to Aba in the Belgian Congo. After returning to Rejaf, a motor car was used for the first part of the eastern journey as far as Lotti in the Opari District. The Akoli Hills and Imatong Mountains were crossed on foot to Logoforok, whence the return to Mongalla was made by motor car. The return from Mongalla to Khartoum was by steamer.

The journey through the Sudan on which this account is based was made, as has just been described, from north to south, and consequently the types of vegetation were encountered in the reverse order to that enumerated above, namely from the desert on the fringe of the West African Region to the Closed Forest, the most developed. The sequence so far as the climatic types are concerned is normal for the West African Region, and although the journey from north to south was at a tangent to the direction of the Gulf of Guinea monsoon, local modifications in the south enable the great belts of vegetation to be prolonged eastwards so that they are continued in the Southern Sudan.

As the traveller enters the Sudan from Egypt he is already in the most arid of the great trans-continental belts of vegetation, and during the journey from Wadi Halfa to Abu Hamed, in one of the luxurious coaches of the Sudan Government Railways, he crosses a typical part of the Nubian Desert. The rainfall of this region is very small and the country is a desert of sand, pebbles, and rock. There is a general absence of vegetation except the isolated *Acacia* bushes, tufted grasses, and hard desert herbs which occur along the drainage lines, in the wadis, or curiously enough on small exposed escarpments. This is the type of country which stretches westwards through the Libyan Desert right across the Sahara, interrupted here and there by areas which are entirely devoid of all plant-life.

The severity of the climate of this region is brought home vividly to the traveller along the Dongola reach of the Nile. The railway from Abu Hamed westwards passes through an arid tract, but on arrival at railhead at Kareima the striking contrast from desert to the greenery of the gardens around the houses and the cultivated strip along the Nile bank under the shade of the date palms, is an experience not likely to be forgotten.

The short trip down-stream on a low river to Merowe between the cultivated river-banks, followed by a stroll in the shady rose gardens and fruit

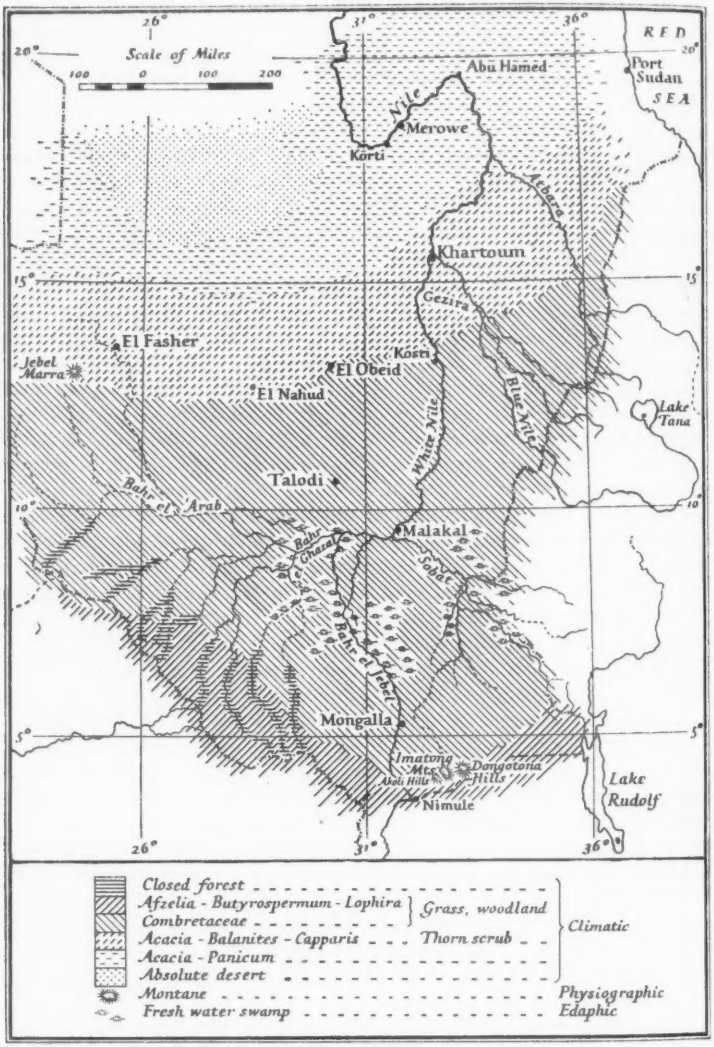


Fig. 3. Vegetation Belts of Anglo-Egyptian Sudan

orchards of the garden city of Merowe itself, prevents one from realizing the ever-pressing desert which is encountered at a sharp line outside the town, where the thin thread of life-giving water, raised daily by motor pump or sagia,

is finally absorbed. These gardens at Merowe (Phot. 2) are a striking testimony to continuity of policy under the most difficult climatic conditions. For more than a quarter of a century Major-General Sir Herbert Jackson Pasha has tended these gardens, first as Governor and later by advising his successors in Dongola Province. Roses and other flowers, oranges, grapefruit, mandarins, grapes and other fruit have been won from this desert margin under a rainless sky, and have made the name of Merowe and its honorary gardener famous throughout the country. What this continuity of policy means is strikingly illustrated in the stretches along the river-bank above Kareima, or down-river from Merowe beyond Korti, where the native sagia cultivation has ceased for a time and the desert has rolled in volumes of golden sand right down to the water's edge, engulfing trees and all plant-life in its advance.

Along these banks lie the routes which slaves to Egypt have followed from time immemorial, and along these same banks is the route followed by our own troops in the early campaigns. The *Waterlily*, which saw service in the Gordon Relief Expedition of 1884 and which has only recently been withdrawn from active service, can be seen now high and dry on the bank at Kareima. It is a country full of the history of yesterday and in vivid contrast to other parts of the Sudan, which can with confidence be called the land of to-morrow.

From Abu Hamed southwards a change in the vegetation is apparent, but this is partly due to the fact that the railway runs in and out along the belt of cultivation alongside the river and through groups of Doum Palm and thickets which are dependent on the water-table of the neighbouring land.

At Atbara, some 1700 miles from its mouth, the Nile receives its last tributary, and in this district the vegetation is becoming general and the next of the transcontinental belts, the Thorn Scrub, is entered. Some rain is general over the area; but the country, desiccated by the wind, is shadeless, dusty, and generally flat, except for the characteristic rocky hills or jebels to be found over most of the northern part of Africa. Perennial streams are absent, and the sparse vegetation is heavily grazed, the branches of the trees being commonly broken down. The bushes are generally isolated, spreading, spherical, or funnel-shaped, and the ground herbaceous flora is seasonal, but becomes more pronounced towards the south of the belt; it is never more than scanty, and the herbs are still characteristically tufted. Standard trees with boles hardly occur. The Kittir Bush (*Acacia mellifera* Benth.), branching from the base and well furnished with thorns, is characteristic, whilst other Acacias, species of *Capparis*, and *Balanites aegyptiaca* provide the other principal bushes and small trees.

A word may here be said about Khartoum, which is in this belt, but with the surrounding vegetation modified and to a great extent entirely destroyed to meet the needs of the population. On arrival at Khartoum one is impressed by the stretches of lawn bordering the main avenues, the lines of roadside trees, the shady gardens surrounding private houses, bright with flower borders around grass tennis courts. It takes little inquiry, however, to learn that the maintenance of these gardens and recreation grounds is effected under the most difficult of tropical conditions. What little rain Khartoum receives is wholly ineffective for this purpose, and the maintenance of these gardens, which make so much for the amenities of life, is entirely dependent on its elaborate

system of irrigation. The width of the roads and the nature of the surrounding country allow clouds of dust and sand to be raised by every wind, and during the hot season this is increased to the sandstorm or haboob which threatens to blot out all forms of plant-life. In passing, a word of tribute should be paid to Mr. F. S. Sillitoe, who has for a quarter of a century worked consistently at the creation and maintenance of these gardens and pleasure grounds in Khartoum, and who latterly has extended his work to other centres such as Port Sudan. The Government has rightly treated the provision and maintenance of gardens as a necessity of life rather than a luxury. This encouragement has been reflected in the efforts of the residents; and in the large centres of population as well as in the most isolated station the development and maintenance of flower, fruit, and vegetable gardens, often under the most disheartening conditions, are one of the most striking features of the home-life of the British population of the Sudan. In most stations the supplies of fresh fruit and vegetables are entirely due to the good will and sacrifice of leisure hours by the Political Officers, and are dependent on the personal interest of the individual.

It is in the Thorn Scrub belt along the Blue Nile below the Sennar Dam that the wonderful Gezira irrigation scheme has resulted in turning hundreds of thousands of acres of this arid type of country into fertile fields of cotton, grain, and fodder. The development of cotton growing in the Sudan is now so generally known that this passing allusion to the great scheme is all that is here necessary.

The grazing and rainland cultivation, more particularly towards the south in this belt, has exercised a modifying influence on the vegetation. Often, as in the uncultivated parts of the Gezira and around Khartoum, the whole former vegetation except a very occasional tree has been entirely removed. In areas farther removed from the activities of man some species have been exploited and others left, thus changing the composition of the vegetation. Thus areas are crossed where the Heglig (*Balanites*) is the only tree remaining, others where the Hekkabit (*Capparis aphylla* Roth.) is the tree which has been spared. Or again, all tree growth has disappeared and large bushes of Ushar (*Calotropis procera* Ait.) are the main feature.

The herdsman is as much concerned in the destruction as is the farmer with his system of shifting cultivation. A camel can graze comfortably off the tops of the small bushy trees; a goat standing on his hind legs has a range of action which few can believe who have not seen it. Apart from this damage the herdsman habitually breaks down the young branches of the trees so that browsing is rendered even more easy. It is small wonder that the most persistent kinds of vegetation are heavily armed, but even here the camel knows quite well how to draw the young *Acacia* branches through his mouth, remove the green leaves, and avoid the long formidable spines. Truly the vegetation has a difficult task to exist at all.

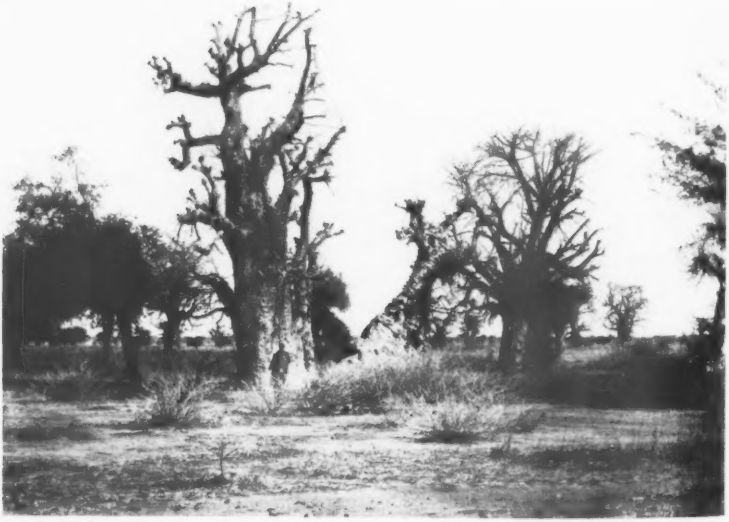
As one journeys southwards the herbs become more general, the grass is taller, and though still all are tufted and the ground bare between, from a distance the appearance is that of a grass plain or undulating country with scattered bushes and small trees.

Then, in some places almost suddenly, as along the watershed from Kosti in White Nile Province to El Nahud in Kordofan, there is a marked change in the

1. Vegetation in a "drainage line" east of Abu Hamed, Nubian desert

2. The Governor's Garden, Merowe, Dongola Province

3. Gum Arabic trees (Acacia Verek) near Rahad



4. Water storage Tebeldis (Adansonia digitata) near El Obeid

arboreal type of vegetation, and the next belt is entered. This is one of the Grass-woodland types, which may be termed the Combretaceous Belt, from the abundance and dominance of the principal trees, the Durut and the Subakh (*Terminalia*), the Sahaba (*Anogeissus*), and the Habil (*Combretum*). The country is generally rolling or undulating with the characteristic isolated jebels, and is intersected by frequent khors. In the Nuba Mountains the jebels are so pronounced and frequent as to govern the general character of the country.

The herbaceous ground-cover is now evident everywhere, though where a pan or shallowness of soil occurs dwarf herbs such as *Blepharis linariifolia* Pers. carpet the ground. One general character of the vegetation persists, however, that all shrubs and plants are armed with thorns, or hooks, or their linear leaves and toughened stems harden into spines. Fruits, especially those of the Heskanit grass (*Cenchrus catharticus* Del.) well known to Saharan travellers, are a general and perfect nuisance to any one who tries to go across country on foot.

The abundance of inflammable material provided by the herbs is responsible for the deformed and gnarled state of the trees. The number of tree species is considerably greater than that occurring in the Thorn Scrub belt, and in addition to the trees *Combretum* (Habil), *Terminalia* (Durut), and *Acacia*, are the Sausage Tree (*Kigelia aethiopica*), the Tamarind (*Tamarindus indicus* L.), and species of *Anogeissus*, *Celtis*, *Sclerocarya*, *Strychnos*, the Paper-bark or Incense Tree (*Boswellia*), *Gardenia*, *Entada*, *Bauhinia*, *Dalbergia*, *Stereospermum*, *Zizyphus*, many Figs (*Ficus*), and other species with connections from the south. Few have opportunity to develop freely, however, and many never get beyond the stage of a pole or stunted bush.

It is in this belt that the well-known Tebeldi (*Adansonia digitata* L.) most commonly occurs, though it is recorded as far north as 15° 15′. The natural factors controlling the distribution and occurrence of this tree are not at present known. It occurs in narrow areas or groups in different places, not apparently connected with climatic or edaphic change. As is well known, in some districts these trees are greatly prized by the local peoples, who fill their hollow trunks with water during the rainy season and so store a supply for use in the dry season, when water from other sources is unobtainable (Phot. 4).

It was remarked in Kordofan that though this tree appeared conspicuously in the landscape in places, all the existing trees were old, and there did not appear to be any young ones coming along to take their places. This is a matter of much concern in some of the gum-tapping districts as the water stored in the trees is the only supply the tappers have while engaged on their work. The trees appeared quite healthy and, at the time this journey was made, last January, they were bearing large crops of fruit. The pulp in which the seeds are embedded in the fruit is considered a delicacy by the natives, and the young Baobab seedlings are equally enjoyed by the villagers' goats. Thus, with more settled conditions of the country, the natives camp farther afield wherever the Baobab provides them with water storage, and at the same time they are preventing regeneration by the destruction of the seedlings, a truly vicious circle. This one more charge laid to the debit of the goat will not affect

that animal, who has wrought such devastation throughout all Mediterranean countries, and is still a serious menace in many parts of the world.

As has just been indicated, the important tree from which the gum arabic of commerce is obtained occurs in this belt and in that previously described, the Thorn Scrub. Gum arabic has been an export of the Sudan from the first century of the Christian era. The Hashab (*Acacia senegal* Willd). from which this gum is obtained is found right across the continent from Senegal to the Red Sea. The tree is 12 to 15 feet high, with a spreading crown and lightly made branches, furnished with hooked thorns. It is found on sandy soils as well as on the black cotton soils. Besides occurring as a natural constituent in the Thorn Scrub vegetation it is found extensively on land which has been subject to " rainland " cultivation but abandoned for a fallow period. On these areas its numbers are considerably increased by sowings, as the natives are fully aware of its economic importance. These areas are locally known as Gum Gardens (Phot. 3).

The yield of gum varies considerably with the weather conditions of the season. Tapping is begun when the leaves wilt and are ready to fall off. The bark is nicked with a small axe, and a strip about 1½ inches broad and 2 feet long pulled off the tree. A different part of the tree is tapped each year. The gum gradually exudes and forms hard nodules or tears which are collected some three to nine weeks later according to the season, collections being made about every ten days. The collected gum is brought by camels to the gum markets, the chief of which is at El Obeid. There it is bought, by daily auction during the season, by European agents, cleaned, prepared, and sacked for transport by train to Port Sudan, whence it is exported. It may be mentioned that a good surface to the hard tennis court in the gum-market towns is made by mixing gum with fine clay, but the mixing and spreading requires to be done by an experienced hand.

The Combretaceous Grass-woodland type of vegetation extends over most of the Sudan south of Kosti except when local conditions favour the presence of an edaphic or physiographic type. Towards the east the belt trends northwards, where it is deflected by the Abyssinian plateau; in the centre a large area is occupied by the great swamps; in the south the Nile–Congo divide and the southern mountains favour other types.

Just as local modifications were seen to have been induced in the Thorn Scrub type resulting on cultivation and grazing, so modifications are seen in the Grass-woodland type, but as there is more inflammable herbaceous material so there is more damage caused by fire. The Nuba Mountains provide, probably, as well-marked an example of the effects of fire as any part of Africa (Phot. 5 and 6). Over the plains enclosed in the mountains the fires have raged for centuries. The inhabitants, who still live in these mountains, evidently regarded the plains as " no man's land," for their cultivation has been carried out on the terraced hillsides. The intervening plains were burnt off so that the approach of the enemy or slave-raiding parties could be seen from afar. This custom of burning is still widely practised, though the terraces are not now so extensively cultivated, and the dwellers in the jebels are coming to live on the plains. The result is, however, that only the quick-growing or fire-resistant species of trees have managed to survive, and whereas a mixed woodland still

occurs on the jebels, the plains are covered with almost pure stretches of different trees according to the nature of the soil. Thus the Red Talh (*Acacia Seyal* Del.) is to be found covering the black cotton soil, the Paper Bark Tree (*Boswellia papyrifera* A. Rich.) on sand, species of *Bauhinia* on rocky areas.

Modifications in the general composition of such a broad belt as this Combretaceous type are to be expected, apart from such drastic alterations as those just indicated for the Nuba Mountains. Thus the vegetation of the lower-lying ground along the Bahr-el-Jebel south of the great swamps, and also of the dry Mongalla plains through which the streams originating in the southern mountains flow, shows a thinning out of some species and greater abundance of others, such as the tree Euphorbias, the Sausage Tree (*Kigelia*), Acacias, *Zizyphus*, and the Combretaceae themselves.

The altitude of the Nile–Congo divide, between 3000 and 4000 feet, and a more liberal and better distributed rainfall enable the fourth of the great transcontinental belts to reach as far as the southern Sudan before turning southwards to encircle the great mass of the Congo forest. The chief physiognomic difference between this and the last type is the greater height and better development of the trees, a more shrubby undergrowth and somewhat shorter grasses. The change in composition is more marked, however, and along the high ground between Rejaf and the Belgian Congo trees commonly occurring are the Red Ironwood (*Lophira alata* Banks), the Shea Butter Tree (*Butyrospermum Parkii* Kotschy), and one of the many "African Mahoganies," *Afzelia africana* Smith.

It is difficult to distinguish this type of vegetation from the preceding by a descriptive term, and it is convenient to consider it as another type of Grass-woodland distinguished by its tree dominants, *Afzelia*, *Butyrospermum*, and *Lophira*. The change to this type is frequently abrupt above the 2000-feet contour. In some places a pure stretch of the tufted bamboo *Oxytenanthera abyssinica* Munro marks the change, and occasionally this bamboo covers hundreds of acres. This Grass-woodland belt curves southwards along the contour through the western part of the Bahr-el-Ghazal and Mongalla Provinces, but appears again to the east of the Bahr-el-Jebel, where the altitude allows, and continues along southern Mongalla north of the Uganda border. In all probability it then trends northwards along the east frontier, but of this we have no definite record.

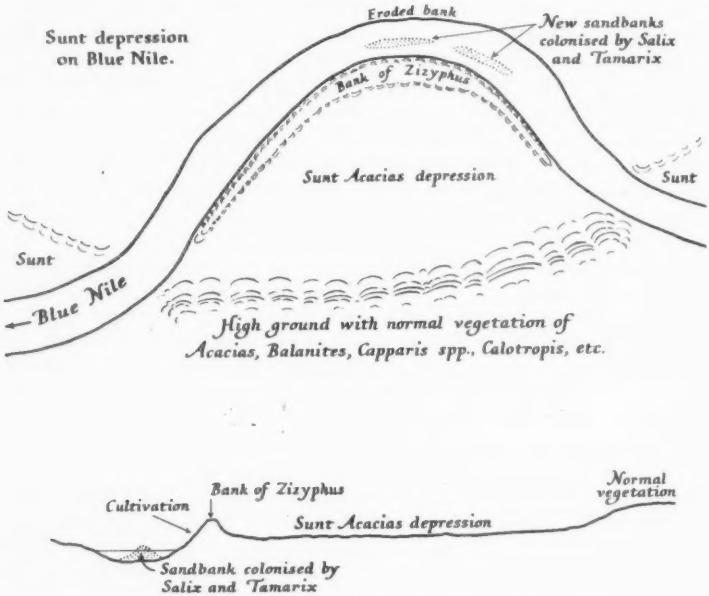
The last of the great African types of vegetation is also to be found in these Provinces; not to any considerable extent, but as invading tongues of forest, along the river valleys and in sheltered basins and ravines between 3000 and 5000 feet altitude. These are the north-eastern limits to which the great Closed Forest of Upper Guinea, the Cameroons, and the Congo penetrates, and massive forest trees of "African Mahogany" (*Khaya*), "African Cedar" (*Entandrophragma*), "African Teak" (*Chlorophora*) and *Alstonia*, a little modified from the western species, betoken a rainfall of some 70 inches a year, and approaching equatorial conditions. The timber obtained from these species is well known locally and prized for constructional work, some even having been transported over 1000 miles and used in Khartoum.

There is another interest attaching to this forest, however, for in the basins

in the Akoli Hills at about 4500 feet altitude, where there are forest patches a few hundred acres in extent, the wild Coffee (*Coffea robusta*) is the chief constituent of the smaller tree stratum. At the time these forests were visited, last February, the coffee trees some 30 feet high were a beautiful picture with their branches smothered in snow-white flowers, whilst the ground beneath them was strewn with the berries of the previous crop. In intimate association with this wild *Coffea robusta* another species of Coffee was found, *Coffea spathicalyx* K. Sch., which hitherto had been recorded only from the Cameroons, thus providing another link in the affinity of these tongues and patches of Sudan forest with the great forest of the west.

2. *Edaphic Types*

We have seen that the Anglo-Egyptian Sudan stretches some 1200 miles across the whole of the five great transcontinental belts of vegetation which



Section across Blue Nile showing Sunt depression.

circle round the Gulf of Guinea and are controlled by the south-west monsoon blowing from the Atlantic Ocean. We may now turn to a consideration of those types of vegetation which are controlled by the water content of the soil, the rivers, and the lakes. Two examples may be taken, the Sunt Forests of the northern Sudan, and the great swamp region of the south central Sudan.

The Sunt Forests in any country less arid than the northern Sudan and providing contrasts less sharp would be termed fringing forests. They are patches

of woodland which occur chiefly along the Main Stream and the Blue Nile, either on the islands in the river, which are seasonally inundated, or in the depressions behind the convex bends, which are always being modified as the river alters its tortuous course.

The first trees to colonize a newly formed sandbank in the streams are a Willow (*Salix Safsaf* Forsk.) and a Tamarix (*T. nilotica* Ehrb.). As these banks are built up by further deposition of sand the more xerophytic vegetation from the neighbouring bank enters, and bushes of Siddir (*Zizyphus*) are the chief plants covering these high narrow protruding banks at the later stage. The depression which becomes enclosed between one of these banks and the old river-bank behind is gradually filled up and colonised by trees of *Acacia arabica* Willd. and *Acacia nilotica* DC., which form the Sunt Forests. The flooding of these depressions, which continues to occur for some time at high Nile, permits the free germination of the *Acacia* seeds, so that the depressions, often many acres in extent, are covered by a pure woodland of *Acacia*. At a later stage, as the depressions get more silted up and their level raised, it is deduced that the Sunt Acacias die out and the normal trees of the neighbouring climatic belt, *Balanites*, *Acacia* spp., *Capparis aphylla* Roth., *Gymnosporia senegalensis* Lam., etc., take possession. Meanwhile the river has been altering its course elsewhere and the process is being repeated. The general result along the Blue Nile is a continuous band of Sunt Forest through which the river winds its way. The value of these forests to the country is considerable, as on them depends the principal firewood supply for the population of the northern Sudan, and fuel for commercial undertakings and for river steamers.

Another product obtained from these Acacias is Sunt grains, the name given to the hard resin-like deposit which is found between the outer and inner coats of the Acacia pods. The seeds contain no tannin and, moreover, are very troublesome to the tanner owing to the ease with which they ferment the tan liquor. The Sunt grains, however, when removed from the pod by crushing and sifting, contain from 50 to 60 per cent. of tannin, and tanners who have conducted technical trials with this material for finishing skins tanned with bark have reported that the results appear to be quite satisfactory. Up to the present the supplies have been used chiefly locally, although up to 1200 tons a year have been exported to Egypt and Italy. These pods are considered a valuable and important Empire source of tannin, and further efforts are now being made, under the auspices of the Imperial Institute, to place the material in a suitable form on the home market.

The vegetation of the great swamp region deserves a rather more detailed description. The greater part of the Upper Nile Province and the north-east of the Bahr-el-Ghazal Province consists of a basin which receives the rivers from the watershed of the Nile–Congo divide on the south-west, the drainage of the African lakes by the Bahr-el-Jebel from the south, and the rivers from the mountains of southern Mongalla on the south-east. Over the north-east corner of this basin trickles the only outlet, the White Nile.

The result of the drainage of these rivers into this basin and the restricted overflow into the White Nile, is the creation of an enormous swamp, nearly under the equatorial cloud belt, and over which a constant equatorial high temperature is maintained.

This basin is for a large part covered with a rank herbaceous vegetation, the swamp part of which is popularly known as the Sudd. The remainder of the basin, where dry land obtains, is covered by the normal Grass-woodland type of vegetation in which the Combretaceae predominate.

The swamp type of vegetation, or the Sudd, consists of free-floating herbs such as *Azolla*, Water-lilies (*Nymphaea*), and Nile Cabbages (*Pistia stratiotes* L.), which occur as a fringe along the open waterways or in open spaces in the swamp, mud-rooted sedges, grasses, and reeds such as the Papyrus (*Cyperus Papyrus* L.), *Phragmites; Echinochloa;* intermingled with them are many herbaceous climbers and creepers, the most conspicuous of which are *Luffa*, *Ipomoea*, and *Vigna*. At some stage these swamp plants thicken into a closely interwoven mat which becomes free-floating. The area which this type of vegetation here occupies has not been ascertained. Experienced observers estimate that there are at least 5000 square miles of almost pure Papyrus. The total area covered by herbaceous vegetation may be more in the neighbourhood of 20,000 square miles. The utilization of this enormous mass of herbaceous vegetation has for some time been under the consideration of Government, and tests have been undertaken to ascertain its value for the manufacture of pulp, power, alcohol, and fuel.

The composition of the swamp vegetation is by no means uniform. The chief components appear to be the Papyrus, the tall grass *Phragmites vulgaris* Crep., and the fringing grass, *Echinochloa pyramidalis* P. Beauv. Each of these grows in well-marked pure stretches covering areas of varying size and shape and alternating with areas covered by the other types, under the control of factors which are not yet known. The vegetation of the Bahr-el-Ghazal, again, is rather different from that of the swamps of the Bahr-el-Jebel.

The only trees which are peculiar to the swamp itself are light-weight Ambatch (*Herminiera elaphroxylon*, Guill. and Perr., and species of *Aeschynomene*) which occurs at the present time as occasional clumps more commonly in the south of the area, but which varies in abundance in different seasons. The branches of these trees are prized locally for making raft canoes and also for mixing with rafts of the heavy Sunt logs to enable them to float. On the Blue Nile the Ambatch is subsequently collected and returned upstream by rail.

The potential yield of ivory from the elephant cemeteries, which we have lately been advised may be expected in such a country, must be something colossal.

This type of vegetation is not peculiar to the Sudan but is to be found in other parts of tropical Africa where similar conditions obtain, such as at lake Chad, around the Victoria Nyanza, and other lakes.

3. *Physiographic Types*

Finally there is the vegetation which is dependent on special local physiographic conditions. This again is not peculiar to any one part of Africa, but is to be found wherever the necessary conditions obtain. The study of this montane vegetation of tropical Africa is of considerable interest. Its history, so far as was then known, is told by Professor J. W. Gregory in *G.J.*, 4, 510, December 1894. Subsequent collections from other localities have provided

additional information which has enabled many isolated threads to be brought together. For a long time, however, this vegetation was known only from the Abyssinian highlands, some of the great East African mountains, and from the Cameroons Peak, 1000 miles to the westward across the great plant-barrier of the Congo forest.

The map shows a group of mountains connecting those of North Africa across the Sahara–Libyan deserts with the tropical mountains. This desert group comprises the mountains of Tasili, Ahaggar, Air, Tibesti, and Jebel Marra in the centre of Darfur. The connection is made with the west tropical group of the Fouta Jalon, the Bauchi Plateau, Fernando Po, the Cameroons Peak, and the north Cameroons highlands.

Eastwards along the peaks of the Nile–Congo divide the extension runs through the mountains of the southern Sudan to the Abyssinian highlands with their extension into Somaliland, Eritrea, and along the Red Sea Hills, across to the Yemen. Again, a connection southwards is made across Elgon, the Aberdares, Kenya, southwards again along the Rift mountains to Kilimanjaro and the north of lake Nyasa. Alternatively, a connection southwards is seen through Ruwenzori and the Virunga volcanoes. From the mountains around lake Nyasa a westwards extension is seen through the Katanga Plateau to the highlands of Benguela, thus encircling the Congo forest. Southwards they may be followed through Milanje and along the Drakensberg range to the Cape.

Over this mountain system extending north and south along Africa with westward and eastward extensions we shall find a vegetation different from that generally found on the continent and consisting of representatives of the vegetation of Europe and of South Africa. Its physiognomic structure may be Closed Forest with trees heavily festooned with lichens, mosses, and ferns, or short scrub, or mountain meadows of short grass or even springy turf.

What the origin of this vegetation may have been is a subject which cannot now be discussed. As our knowledge of the vegetation of these mountains increases we find, as it were, a disconnected bridge on which occur representatives of the north and south temperate flora, carried over the equator in Africa at a general height of 8000 feet upwards. Through its Abyssinian extension connections are even found with the Himalayan flora. Thus Brambles (*Rubus*), Olives (*Olea*), Buttercups (*Ranunculus*), Larkspurs (*Delphinium*) and *Clematis* grow in association with the Tree Ferns (*Cyathea*), the Proteas, the Irid *Moraea*, *Lasiosiphon*, and the Heaths (*Erica*). Again, there are some highly specialized forms of equatorial regions generally, such as the Giant Lobelias and Groundsels, which are also to be found here growing in forests whose chief constituent trees are *Podocarpus*, Junipers and Olives, genera which are distributed over the whole mountain system of Africa from the Mediterranean to the Cape.

We are gradually accumulating records which show the distribution through this high-level vegetation of Mediterranean types southwards to the Cape and of Cape types northwards to the Mediterranean; there are also peculiar montane types found only in the tropics which occur here; there are other types found in the Mediterranean and Cape regions which appear common equally to each and also to the montane vegetation of tropical Africa. At the same time it must be noticed that the vegetation of the low-level climatic belts which forms the

general vegetation of the continent does not occur at altitudes where the montane vegetation is at its optimum. It does not appear correct, in the light of our new knowledge, to regard the areas occupied by this montane vegetation as a "no man's land" over which representatives from the north and south temperate regions have migrated. The connections which it establishes makes one almost hesitate to differentiate what is Mediterranean and what is South African when one sees so much common to both in the intervening area.

Indeed, in some cases it is becoming difficult to say whether they should be regarded as of northern origin as opposed to southern origin or vice versa. At the same time the possibility of parallel development in the two hemispheres can hardly be supported now that the montane vegetation over the length of Africa is becoming known.

One new station is recorded from the Imatong Mountains of the southern Sudan, the result of the journey described in this paper. It forms an interesting connection in the chain from Jebel Marra along the Nile–Congo divide, eastwards to Abyssinia and southwards to the Uganda mountains. Only a few plants were collected, and we have only a few from Jebel Marra, whilst the high vegetation of the great northern mountains—the Tibesti and Tasili groups, etc.—across the desert is practically unknown.

Whether, when the opportunity comes for a botanist to explore these mountains, many of the northern connections of this montane vegetation will be able to be traced, is a matter for conjecture. The destruction of the vegetation of these climatically inhospitable Saharan regions, chiefly by the pastoralists but also consequent on the abandonment of agriculture, during comparatively recent times, has extended at such a pace that even now, according to competent French authorities, it is only by the presence of a few individuals that have lingered on, even after they have lost the power of reproduction, that any idea can be obtained of the vegetation which once covered these highland plateaux. This is a field of peculiar scientific interest where every traveller has an opportunity of adding to our knowledge.

With regard to the Sudan itself, apart from the small collections which have been made on Jebel Marra and the Imatong Mountains and from the northern spur of the Abyssinian plateau around Erkowit, the vegetation of the jebels is practically unknown. The smaller jebels from which most of the vegetation has been burnt off are not likely to prove of special interest, and what vegetation is left on them will no doubt be found to be that of the vegetation belt in which the jebel occurs. In the case of the greater mountain masses, however, there is every possibility of most interesting records being obtained.

A brief description of the vegetation zones found on the Imatongs will show the difference between them and those of the climatic belts already described. The climatic belts, it will be remembered, included the Closed Forest which was found up to some 4500 feet in the Akoli Hills. These lie around the west and south of the Imatongs whose eastern edge, in sharp contrast, drops almost precipitously some 6000 feet into the Mongalla plains. Above the zone in which the Closed Forest occurs, the Grass Woodland again comes in and clothes the mountain-sides. A marked difference, however, is seen in the gradual disappearance of the tree species found at lower levels and the almost abrupt appearance at about 5000 feet of the flat-topped *Acacia abyssinica*, a conspicuous

5. Tall grasses and fire-gnarled trees near Talodi

6. Effects of fires on Nuba forests: trees small and gnarled

Phot. W. J. McBain.

7. Mount Kineti from Kippia rest house (9000 ft.), Mongalla, Sudan

8. Podocarpus forest (8500 ft.) showing spike-like Lobelia gibberoa

tree of the landscape. The grasses are different, the bracken fern is common, and epiphytes are found on the trees.

At about the same altitude there is a change in the flora of the ravines and the montane plants begin to appear as those of the Closed Forest cease. At 8000 feet the change is complete, and the montane forest, characterized by tall *Podocarpus* trees (Phot. 8), with its closed canopy and festoons of epiphytic lichens, mosses, and ferns, alternating with mountain meadows of short grass, extends over the whole mountain-top, in its general aspect not at all unlike our highland scenery at home. The mountain bamboo, which forms characteristic belts around the more equatorial mountains, exists here only on the edge of the forest patches. The time spent in crossing the range, however, was only a few days, and but a very small percentage of the flora could be collected.

Over the 10,000-feet limit the trees are found in the more sheltered spots in the form of bushes only, and on the mountain-top the vegetation is a short springing turf between the rocky outcrops, under shelter of which are pretty little Lobelias, stemless Thistles, and dwarf Everlasting Flowers. A more detailed account of the vegetation of the Imatong Mountains is given in *Kew Bulletin*, 1929, pp. 177–196.

This brief survey of the Anglo-Egyptian Sudan has indicated that every type of vegetation of northern tropical Africa is represented in that country. As is the case with nearly all the possessions of the Great Powers in the northern part of the continent, the Sudan cuts right across the natural belts of vegetation. In both west and north-east Africa we find, therefore, that each administration is provided with similar economic conditions, working out within its own political confines problems which are common to all. In this respect the British are at a greater disadvantage than the French, for whereas the French territory is continuous, the British territories are definitely separated by areas under foreign jurisdiction. It would appear that a time must soon come when field research problems, separated from local administrative and political questions, will have to be prosecuted right across the continent regardless of political boundaries.

DISCUSSION

Before the paper the PRESIDENT (Colonel Sir CHARLES CLOSE) said: Before I introduce the lecturer I should like to make one or two remarks. First of all, those who know the neighbourhood of Kensington Gore will have seen that the Society's new building is in a very advanced stage, being 25 feet above ground, so that those Fellows who wish may go inside the building and see what shape it is going to assume. All those who know anything about buildings are satisfied with it and think it will be an admirable acquisition to our Society's premises, at the same time endowing our Society with a lecture hall and adjuncts which no other society of the kind has. Out of the £20,000 which we hoped to obtain we have received over £15,000, and we shall be very glad of the remaining £5000.

Now with regard to this evening's programme I should, if there was time, ask you to meditate on the blessed word "ecology." There may be those here who are perfectly certain what the word means. I have had the advantage of sitting between two experts at dinner, and I think I know something about it, though their definitions are not perfectly identical. We are this evening to deal with

vegetational subjects, and ecology enters into them a great deal. Dr. Chipp, who is to lecture, began his investigations into plant-life on the West Coast of Africa. Now he has directed his attention to the Sudan, and to-night we shall hear about the trees and plants of that enormous area known as the Anglo-Egyptian Sudan, which is something like 1,000,000 square miles in extent. Dr. Chipp is the Assistant Director of the Royal Botanic Gardens at Kew, better known as Kew Gardens, and I understand he was sent to the Sudan by the Empire Marketing Board with the intention of ascertaining the economic possibilities of the Sudan. It is some time since we have had a lecture on a botanic subject. We have heard recently of the activities of the coral insect, if it is an insect, but to-night we shall deal with another aspect of biology, and I am perfectly sure those present will be only too anxious to hear what Dr. Chipp has to say.

Dr. Chipp then read the paper printed above, and a discussion followed.

The PRESIDENT: We are very fortunate in having with us Dr. Hill, Director of Kew Gardens, and we should all like to hear him discuss the various points which have been brought forward by Dr. Chipp. But before he does that perhaps he would say a few words on the relations between botanic gardens and sewage farms.

Dr. A. W. HILL: As you have so kindly asked me to say something about this burning question of Syon House and the Middlesex County Council I am grateful for the opportunity, because I feel sure that everybody here is as alarmed as I am at any prospect of the destruction of that wonderful view along the reach of the Thames, or the Syon Reach, from Kew towards Isleworth: an historic view which has certainly been almost untouched for the last 160 years, as shown by two pictures which appeared in *The Times* last Saturday, one from the painting by Richard Wilson in 1776, and the other a photograph taken from almost the same spot a few weeks ago. As far as I understand, the proposal of the Middlesex County Council would entail an embankment along the river-side of the Syon front, which would entirely destroy the whole beauty of the sylvan landscape. Thus I hope, Mr. President, you and this Society will join with the President of the Royal Academy and other learned bodies in using all your endeavours to defeat a scheme so detrimental not only to London but to the whole of the Empire.

Now, sir, having disposed of the red herring you have drawn across my path, I should like to say I am very sorry that the Secretary of the Empire Marketing Board is not here, because I think he would very much have appreciated Dr. Chipp's account of his travels in the Sudan, which have really been made possible entirely by the grant that the Empire Marketing Board made to Kew a few years ago. As soon as the Sudan Government knew of the grant to Kew to enable one of us to visit some part of the Empire to study local problems on the spot and to get in touch with the authorities, we received invitations from Australia, New Zealand, and Africa; and learning that some of the problems in the Sudan dealt with forestry, I thought that Dr. Chipp was the right man to go there as he had experience of forestry in West Africa and also in the Federated Malay States. Though he has this evening given us an extremely interesting account of the vegetation, that was not the reason why he went to the Sudan. He went at the request of the Sudan Government to advise them on various problems of State agricultural service and the recruiting of their staff and all sorts of local problems in their administration, but in odd moments his interest in other matters got the better of him and he went dashing off, with their assistance, right down to the Imatong Mountains.

Dr. Chipp has shown that the vegetation on those mountains is of great interest, because it links up the high mountains of West Africa and in the south with the Atlas Mountains in the north. I am hoping that we may get further light on

some of the high mountain vegetation because, also thanks to the Empire Marketing Board grant, I have been able to arrange with the Colonial Office and the War Office for a botanist to join the expedition now engaged in demarcating the boundary between British and Italian Somaliland. Our member of that expedition has written home reporting that there are mountains on that boundary which, like the Imatong Mountains, are not at all clearly shown on most maps, but which certainly rise to over 7000 feet. I think we may find vegetation there showing links with some of the plants that Dr. Chipp has described. The opportunity we now have at Kew of going to see distant parts of the Empire and getting in touch with botanists overseas is an extraordinarily useful development which arose, I may tell you, out of a chance conversation at lunch between myself and the Secretary of the Empire Marketing Board.

I do not think I need go into the botanical details of Dr. Chipp's lecture, because he has so fully described the salient features of the vegetation he saw that there is really nothing for me to do except congratulate him on the clear account he has given of his wanderings in that interesting region.

The PRESIDENT: We are all very glad that a luncheon resulted in co-operation between the Empire Marketing Board, Kew, and the Sudan Government. Dr. Chipp is a very high authority on the botany of Africa north of the Equator, and we have listened to an extraordinarily interesting lecture. One of the points I have gathered from it is that man the destroyer is the native and man the preserver is the white man. As I said from this platform a little time ago, Europe has taken charge of Africa. Therefore it is up to Europe to see that the country is not destroyed, and, in fact, where we are in control we are taking care that Africa is looked after. I hope in future we shall hear less of the destruction which Dr. Chipp has described. He has given us a most excellent lecture, and I am sure, in your name, I may thank him.

THE APPLICATION OF STEREOSCOPIC PHOTOGRAPHY TO MAPPING: *A paper read at the Afternoon Meeting of the Society, 11 November 1929, by*

CAPTAIN M. HOTINE, R.E., Geographical Section, General Staff

THE surveying camera is really an instantaneous, yet fairly accurate, theodolite. A single photograph exposed in it will do no more than provide a rapid record of angles which could be measured from the camera station. If the photograph is exposed in a vertical plane, then it becomes an easy matter to derive horizontal and vertical angles from it by measurements on the plate or by simple graphical constructions. This, then, constitutes the first and most direct method of photographic survey which is still used with advantage for small-scale work in the mountains of British Columbia. Photographs are exposed at 1 and 2 (Fig. 1) from the ends of a long base and are

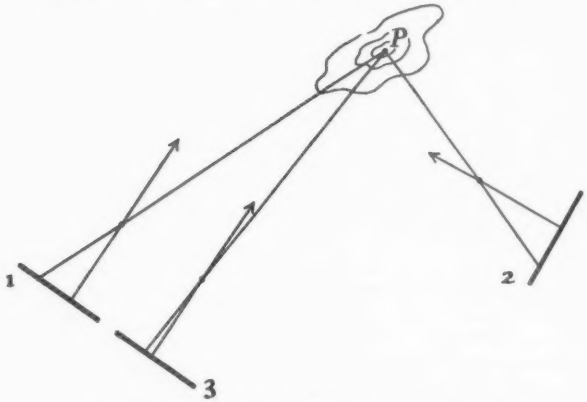


Fig. 1. Direct method of photographic survey

used to intersect the position, and determine the height, of detail appearing on both photographs.

The main trouble in this class of work is that the same object P may have an entirely different appearance on each of the widely dissimilar views, and it becomes easy to intersect the wrong point or to provide an inaccurate fixation of the right point. The difficulty may be overcome by exposing photographs at 1 and 3, from the ends of a short base, but in that case we should obtain a narrow angle intersection which is the bane of all good graphical surveyors. To overcome this further difficulty, graphical methods were given up in favour of precise micrometric measurements on the photographic plates, coupled with the stereoscopic examination of the photographs in order that corresponding images might be identified with certainty. The stereoscope is in this case merely a convenient means of seeing two things at once, and has no particular magic of its own.

If we continue to expose the photographs in vertical planes, then we shall

retain that facility for the simple determination of horizontal and vertical directions from either camera station. If we go farther and expose the two photographs in the same vertical plane, then it becomes a simple matter to convert stereoscopic measurements on the photographs into horizontal distances from the base line, and thus provide a complete fixation. Full details of this system have been printed from time to time—for example, in an article by Lieutenant (later Brigadier-General) F. V. Thompson on "Stereo-photo Surveying" in the *Geographical Journal* (31, 534, May 1908)—and it is not proposed to repeat them here. The general principle on which the measurement rests is illustrated by Fig. 2. Any natural object will give rise at exposure to corresponding images o and o' on photographs P and P' taken from the ends of the base EE'. During stereoscopic examination, the photographs may be viewed from E and E' in such a manner that only one picture is presented to each eye. The stereoscopically fused image of the original natural object will then appear to lie at O. A pair of artificial "floating marks" ff', in optical contact with the photographs, will similarly give rise to a stereoscopically fused image at F. By moving o or f in the plane of the diagram the relative distances of O and F from the eyes can be varied. The amount of this motion to produce apparent equality in distance between O and F—which occurs when $oo'=ff'$—is measured micrometrically and is used in a simple formula to determine the corresponding distance in Nature. This simple discussion is open to several more or less academic objections, but it will suffice for a condensed practical explanation. A full account of the subject will be found in Professional Paper No. 4 of the Air Survey Committee, although even that is not entirely free from academic objection. This system was first applied practically in Fourcade's Stereocomparator (Pl. 1) about 1900. The widespread belief that Pulfrich of Zeiss was first in the field is entirely due to the fact that Mr. Fourcade was and still is modest about his achievement. Reference should be made to Mr. Fourcade's own description of the construction and use of this instrument in the *Transactions of the Royal Society of South Africa* (vol. 14, 1926, p. 83). It might still be used with advantage for small-scale surveys of mountainous country, where the main requirement is a framework of point fixings on which to hang intermediate sketching, and which could not pay the overhead costs of modern automatic machines.

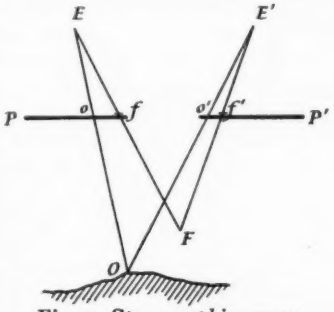


Fig. 2. Stereographic survey

In order to secure as much ground as possible on a pair of photographs, it was later found desirable to give up the restriction to exposure in the same vertical plane and to expose the photographs on tilted and converging orientations. At the same time, attempts were made to avoid the labour and possible mistakes involved in any system of point-by-point plotting and to substitute some means of automatically plotting plans and contours from the perspective stereoscopic view. These attempts have led to the evolution of such machines

as the Thompson Stereoplotter, the Von Orel Stereoautograph, the Hugershoff Autocartograph, the Wild Autograph, which have been described from time to time in the Society's *Journal*. The first machine of this type (Fig. 3) is due to Deville, the late Surveyor-General of Canada. The photographs were viewed by reflection at the surfaces of two half-silvered mirrors under such conditions of distance and position relative to the eyes as would serve to re-establish the internal perspective of the field camera. The photographs and mirrors were further adjusted to reproduce the external orientation of the two views, when a virtual true-to-scale stereoscopic image of the landscape could be seen, apparently behind the mirrors. A "floating mark" consisting of an adjustable target carried on a movable vertical column could be moved about in this virtual image in apparent coincidence with various natural features. A pencil at the base of the column plotted the position of such a natural feature, while the height of the target above the plotting board furnished a measure of relative altitude. For pure simplicity this arrangement has never been surpassed, but unfortunately it has certain optical and mechanical disadvantages

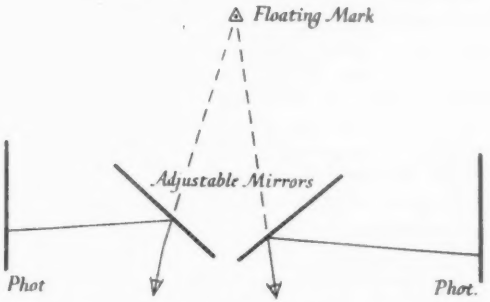


Fig. 3. Deville's Stereoscopic Plotter

which decided the inventor against its full development. It is interesting to note that the same principle of a real "floating mark" has been used in at least two modern machines.

The last machine of this type is that finished piece of intricate workmanship known as the Wild Autograph (see *G.J.*, 70, 358, October 1927), which provides a complete, if complicated, answer to any orientation or tilt whatsoever of the camera during exposure, provided such exposure conditions are measured on the ground or can be subsequently determined. It is used extensively for ground surveys in mountainous regions, and is probably an economic proposition on medium or large scales. There is little doubt about the excellence of the maps produced under these conditions. Even in mountainous country consisting of well-defined steep ridges, as opposed to broken country, certain areas of dead ground appear on the ground views, but no difficulty is experienced in filling these by the plane-table.

This stage of development has by no means been neglected in this country. Messrs. Barr & Stroud have produced a Photogrammetric Plotter which is superior in general conception and practical simplicity to any Continental

model. Like all first models, it contains certain mechanical defects which can easily be remedied in subsequent instruments.

The introduction of photography from the air has considerably extended the possible applications of photographic surveys by providing suitable views of flat or undulating country, with the further advantage that longer bases are usually possible than in the case of ground stereographic surveys. It has, however, introduced the problem of unknown exposure conditions, for whereas the position, tilt, and orientation of a photograph exposed deliberately on the ground can easily be measured directly, none of these quantities has so far been obtained directly in the case of air photographs. The aeroplane travels so fast that its position cannot be established to any useful degree of approximation, while random accelerations preclude a determination of level closer than a few degrees. Most of the machines mentioned above were designed on the assumption that the exposure conditions were obtainable by direct measurement, and they consequently depended on this facility for rapid and economic setting of the photographs, in their correct positions for plotting. Wholehearted, if perhaps misguided, efforts have subsequently been made to adapt them to the case of unknown exposure conditions. The conditions are however so entirely different from those obtaining in the case of ground photographs that it is safe to say, in the light of after knowledge, that the whole question should have been tackled afresh.

An individual air photograph, or an individual stereoscopic pair of air photographs, requires some form of surveyed ground control in order to establish these exposure conditions. Failing direct measurement in the air, which is not likely to be realized with sufficient accuracy for many purposes, there is no alternative. Originally attempts were made, notably by Professor Hugershoff, to establish the exposure conditions of single photographs from ground control by calculation. Such methods have been considerably shortened in this country by Captain McCaw, but even so, no economically practicable system of computation has been evolved. Linear and angular dimensions are so hopelessly intermingled in this problem that a simple solution is never likely to be discovered. The difficulty has been overcome in an instrument invented by Lieut.-Colonel (now Colonel) MacLeod known as the "Tilt Finder" and constructed by Messrs. Barr & Stroud, as a means of providing the setting data for their Photogrammetric Plotter. The experimental model of this instrument contains certain optical defects which limit its accuracy to about 15 minutes of tilt, but it is reasonable to suppose that these could be eliminated in subsequent design. A more promising field than the treatment of single photographs has however opened recently, and further development of the instrument is consequently in abeyance.

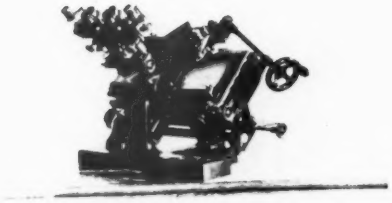
The usual system of setting now practised is to set a stereoscopic pair simultaneously, using the principle of "correspondence setting" originally devised by Mr. Fourcade about 1925. The photographs are first set relatively "in correspondence," which simply implies that the visual directions to corresponding points of photographic detail shall intersect in single image points to produce a true stereoscopic image of the landscape. This operation requires no ground control. Secondly, both photographs are moved together in order to establish the scale and level of the stereoscopic image from ground control.

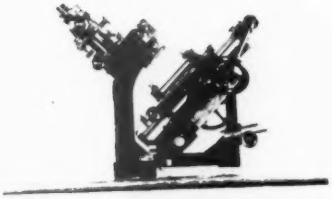
We shall see later how Mr. Fourcade himself applies this principle. For the moment it will suffice to say that the movements of all Continental machines are not suited to the application of this new method of setting. The first operation of correspondence setting can usually be performed reasonably quickly and accurately, but the subsequent settings for scale and level destroy the initial correspondence setting, with the result that the whole operation has to be repeated by trial and error. A good final result can undoubtedly be obtained, but hardly at an economic speed.

The modification of Continental machines to deal with the setting of air photographs has led to a good deal of instrumental "patchwork." The most notable example is the Wild Autograph, in which an additional movement is now employed. This machine produces excellent 6-inch maps from air photographs, at the rate of 1 sq. mile in 16 hours. Using a somewhat different principle, Mr. Brock, of the firm of Brock & Weymouth, Philadelphia, has devised a modified method of using the original stereocomparator with vertical air photographs. Here again excellent maps are produced, but four hours are consumed in the tilt correction of one pair of plates. The complexity of these modified ground machines, and the time required for setting air photographs in them, mean that they cannot economically be used for air surveys on topographic scales. In addition they mostly require a dense ground control, which adds very considerably to the cost.

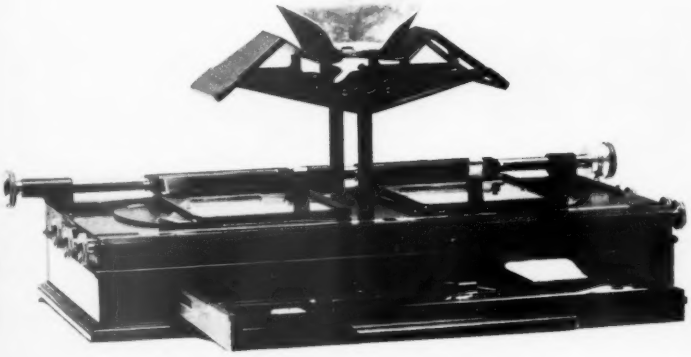
Concurrently with such instrumental methods, various simple and wilfully approximate methods of dealing with vertical air photographs have been evolved in order to solve the problem of topographic scales. We have, for instance, the "mosaic" or composite photograph obtained by sticking individual prints together on a common base. In the hands of enthusiasts this "mosaic" idea has from time to time been the subject of gross exaggeration and over-statement, with the result that it is looked on by many surveyors with far more distrust than it actually deserves. The truth is that it furnishes a rapid means of obtaining a very detailed picture of an area of flat country, which may often be used as material for topographic mapping not requiring a greater degree of accuracy in the measurement of short distances than 2 or 3 per cent. In undulating country it is less valuable—on account of the differences in scale occurring at different levels—while in hilly country it cannot be compiled at all. I have, indeed, recently seen a "precise mosaic" of part of the American Rockies, obtained by cutting out portions of the photographs at the same contour level, subjecting these portions to an individual degree of enlargement, and assembling in much the same manner as a relief map. Apart from the prohibitive amount of time required to compile such a mosaic, a knowledge of the relief has to be acquired which in that type of country amounts almost to complete mapping. It is interesting, but can hardly be considered a serious contribution to economic mapping.

While still retaining the merit of simplicity, we can improve very considerably on the mosaic by graphical plotting and by simple stereoscopic interpolation of heights and contours between a network of control heights fixed on the ground. Such a method has perhaps been developed in greater detail in this country than in any other, although the principles on which it rests are age-old. There is, indeed, some doubt as to whether the credit should be given to the

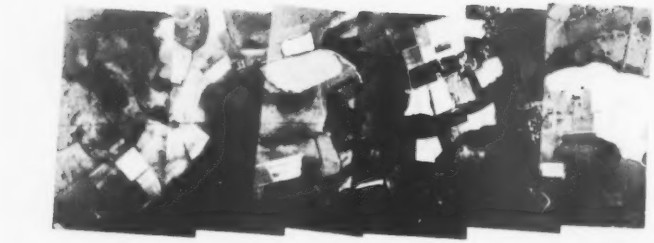


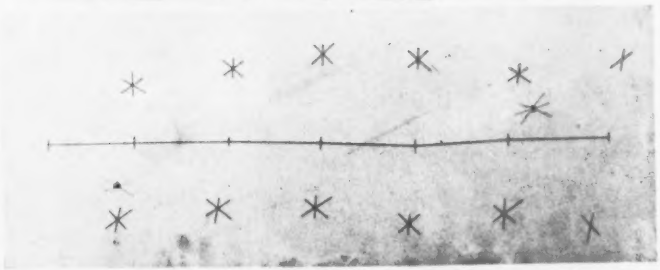


1. Fourcade's Stereocomparator



2. Barr and Stroud Topographical Stereoscope





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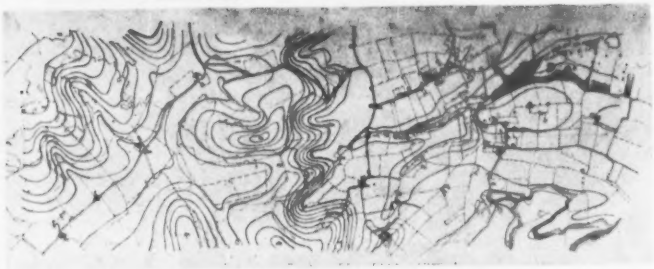


4

3. Experimental Survey: Arundel Method

inventor of the plane-table, whoever that was, or to a gentleman in the United States who dealt in photographs taken from balloons about 1898. We call this the "Arundel" method because it was first put into practice in this country in an experimental area near Arundel. Part of this experimental survey is illustrated in Pl. 3 in the various stages of blank photographs, control plotting, contoured photographs and finished map. The only instrument used in present practice is the Topographical Stereoscope constructed by Messrs. Barr & Stroud and illustrated in Pl. 2.

The Arundel method produces excellent topographical maps rapidly and cheaply, but in its simplest form its application is restricted to country varying in relief by not more than 10 per cent. of the altitude of flight. It also requires a network of ground heights—something like 4 or 5 per square mile—and fixed positions every 5 to 10 miles. Good draughtsmanship is essential for the purely graphical plotting, although this can be replaced by a simple extension employing a little computation. Under these conditions, the method will continue to be used in spite of any foreseen future development. The burning questions of time and money will always ensure that no more complicated method is used than the scale and purpose of the survey warrant.

An attempt has recently been made to avoid the restriction imposed on permissible relief of the ground by obtaining the tilt of each photograph from a form of computation based on Fourcade's correspondence principle. No additional ground control is required, but the time of plotting is increased by half an hour to an hour per photograph. This method also takes its name from the location of the experimental survey near Clova in the Eastern Highlands of Scotland. So far as results are concerned this experimental survey was entirely successful. Unfortunately, the method is rather too complicated for routine work in large areas. The same process will probably be simplified and quickened by using the Fourcade Stereogoniometer (described below) or by developments in air navigation tending to more stabilized flying. Gyroscopically controlled aircraft may, for instance, make it possible to limit the determination of tilt to, say, every tenth picture.

Full details of the Arundel and Clova methods will be found in Professional Papers Nos. 3, 4 and 6 of the Air Survey Committee.

To overcome the limitations of the Arundel method on topographic scales, as regards relief and close height control, as well as to provide a ready means of tackling larger scales, the tendency is to employ a machine, but a machine designed expressly for the unknown exposure conditions obtaining in the case of air photographs. I refer to the Fourcade Stereogoniometer, which is shown diagrammatically in Fig. 4. Essentially, the machine consists of a pair of cameras CC' in whose focal planes are placed the photographs under examination. The position of the photographs, and the lenses of the two cameras, can be adjusted to correspond with the camera in which the photographs were originally exposed. The photographs are observed through a fixed binocular telescope system T provided with floating marks, the sighting rays being reflected into the camera objectives by two plane mirrors M and M'.

In order that different parts of the photographic field in a vertical direction may be brought under examination, both cameras may be swung *together* about a horizontal axis PP', which represents the base line joining the two camera

stations. To bring different parts of the field in a horizontal direction under examination the mirror carriers are movable together in a direction parallel to *PP'*. At the same time the mirrors themselves are automatically rotated about vertical axes by the amount necessary to ensure that the perspective ray to the point sighted is reflected along the fixed line of collimation of the telescope (see the dotted position of the mirrors in Fig. 4). To vary the convergence of the sighting rays, and thus alter the apparent stereoscopic depth of the photographic image in relation to the floating marks, provision is made for a similar movement of the right-hand mirror only.

In addition to these three observation movements, five setting movements are provided in order to bring the two photographs into correspondence, as defined above, and thus into their correct positions relative to one another and to the base line. These movements are indicated on Fig. 4 by arrows. The first model of the instrument is shown in Pl. 4. A new model is now being designed by Mr. Fourcade with an automatic plotting mechanism which is coupled to the observation movements.

There are four main points about this instrument to which I should like to

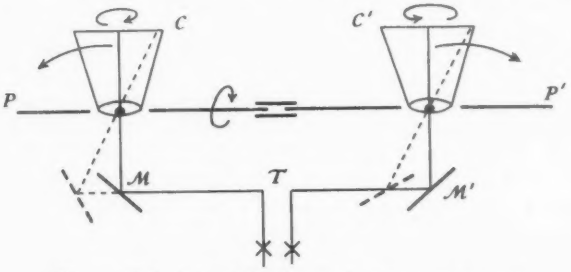


Fig. 4. Principle of the Fourcade Stereogoniometer

call your particular attention. The first is that the correspondence setting movements are made in respect to the base line, to which they are properly related, and not, as in all Continental machines, to the horizontal. The result is a quicker and more accurate relative setting in cases where the base line is inclined to the horizontal. The second is that the observation, or plotting, movements are entirely distinct from the setting movements and have no effect on the previously established correspondence of the photographs. The result is that both trial and error are reduced to a minimum. The third is that no hard-and-fast type of ground control is required. Depending on the scale and purpose of the survey, the control may vary from a base length and two angles of elevation or depression on each pair of photographs, to a similar amount of control at each end of a strip of photographs; from an ordinary triangulation, to a simple record of altitudes measured in the air. The fourth is that the use of the instrument may vary from the determination of tilts and spot heights for rapid detail plotting by the Arundel method to automatic plotting for more deliberate or larger scale surveys. These considerations would appear to indicate a wider field of practical application than has hitherto been possible with the Continental machines.

THE BARR AND STROUD PHOTOGRAMMETRIC PLOTTER

In the course of the preceding paper I remarked that the Barr and Stroud Photogrammetric Plotter was "superior in conception and practical simplicity" to any Continental machine designed for the same purpose. During the subsequent discussion this statement was received with some scepticism, due perhaps to an undue British reticence. The Barr and Stroud machine has not yet been described, but if silence is being taken as a sign of failure, then it is

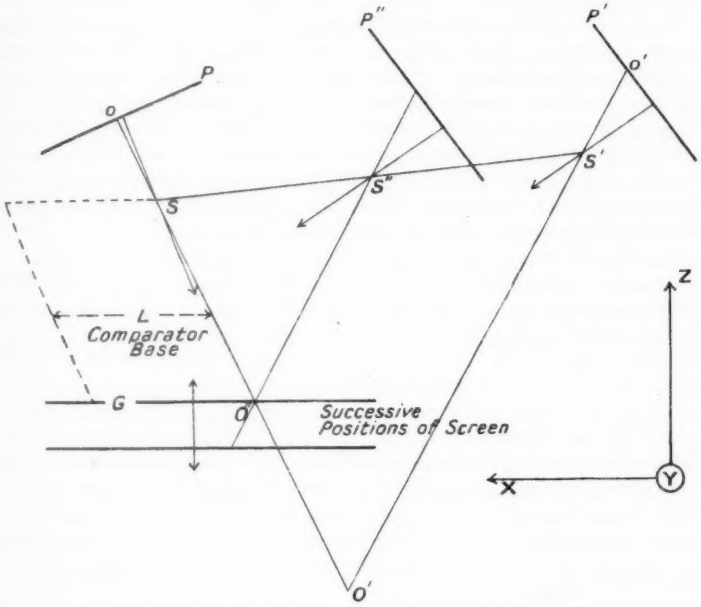


Fig. 5. Geometry of the Photogrammetric Plotter

indeed time for this defect to be remedied. Professor Barr, the designer of the machine, could have written a far better description, and I asked him if he would consent to do so. In a way I am glad that he refused. My own efforts will be less hampered by the modesty pertaining to and becoming the designer himself.

Geometrical Principles and Plotting Movements

Imagine a pair of air photographs P, P' (Fig. 5) exposed at the ends of a base SS' and covering, in whole or in part, the same area of country. If the plates were taken out, developed and put back in their original positions in the cameras—which for the moment are assumed not to have been moved—then it is clear that light-rays originating in corresponding image points o, o' on the photographs and passing through the camera lenses would intersect in the position of the natural object O' which gave rise originally to such corresponding

images. Theoretically, at any rate, this would provide a means of "reconstructing" the original landscape to its natural scale.

Instead of keeping the cameras immovable between exposure and reconstruction, suppose that we move $S'P'$ always parallel to itself and in the direction of the base-line SS' until it takes up a position $S''P''$. The reconstructed landscape (of which O'' is one point) will now be similar in all respects to the original landscape, but reduced in all linear dimensions in the ratio SS''/SS'. A little consideration will show that this must be so, without the necessity for a mathematical proof.

Suppose that we take a screen G to represent a horizontal plane in Nature and arrange to give it a single movement perpendicular to its plane, that is, in the vertical direction in Nature. When the two corresponding images caught on this screen coincide in a single point O'', then the position of O'' on the screen will provide its plan position in relation to the position of the base-line SS''. If the rays originally came from a point at a higher level than O', the screen G would have to be moved higher in order that the two rays might meet on the plane of the screen. Movements of the screen for various points on the ground therefore give a measure of the relative levels of these points.

Equally well, we may keep the screen fixed and bring the two corresponding images into coincidence at O'' by moving both cameras together in a direction at right angles to the screen. The amount of this movement of the cameras (known as the Z-motion) will now furnish a measure of vertical heights. It will be evident that all points on the ground at the same level as O' will have their two projected images coincident on the screen, and the plan positions on the screen of these images will correspond to the plan positions of the original points on the ground. When the level of the screen, or the distance from it of the cameras, is altered to bring a fresh set of points into coincidence, the plan positions of these other images will as before correspond to the plan positions of the original points on the ground. A pencil moving over a drawing-board in such a manner that its movements are always equal and parallel to corresponding distances between coincident screen images will plot the plan positions of these screen images.

As a further possibility, we may provide two more movements for the cameras and thereby bring corresponding screen images into coincidence with a particular point on the fixed screen. These movements, which are both parallel to the plane of the screen and, for convenience, are arranged in directions at right angles to one another, provide a means of establishing the relative plan co-ordinates of such points as O''. If these movements, known as the X- and Y-motions, are imported by direct gearing to the drawing-board, then the pencil, which is now considered fixed, will automatically plot plan positions.

Either of the methods described in the last two paragraphs may be employed for plotting plan positions. Actually, both methods are used in a manner which will appear later.

Before plotting, we have seen that the photographs have first to be replaced in projection cameras geometrically similar to the field cameras. These projection cameras are provided with certain setting movements in order that they may occupy the same positions relative to the machine base-line (SS'' in Fig. 5) and to the plane of the screen as the original field cameras occupied relative to

the field base (SS' in Fig. 5) and to the horizontal plane in Nature. By means of the plotting movements described above we are then able to derive a correct plan of the landscape and also a measure of relative heights. The scale of the resulting map, in all three dimensions, will be SS''/SS'.

If the photographs had been exposed on the ground instead of in the air, in such a manner that they occupied planes more nearly vertical than horizontal, then we consider the plane of the screen to represent a vertical plane in Nature. In that case, the Z-motion of the machine affords a measure of horizontal distances, and the Y-motion affords a measure of heights. If the X- and Z-motions are now coupled to the drawing-board—instead of the X- and Y-motions—we are still able to draw direct plans. By this means the machine is made capable of dealing with photographs at any inclination whatsoever.

In one respect only does the geometry of the actual machine depart from the foregoing simple description. The two projectors are separated in the X-direction by an arbitrary amount L from the theoretical positions SS'' of Fig. 5. The two screen images are then no longer observed in actual coincidence but are considered as coincident—for the purpose of plotting—when they fall at the same distance (L) apart as the projectors have been separated. The increased separation L is known as the "comparator base." This device is employed also in most Continental machines. Mechanically it provides more room for the projectors, and optically it enables the two views to be examined stereoscopically without the necessity for first disentangling the images of the two pictures.

Optical Principles

For the internal perspectives of the two photographs to be correctly re-established, we have seen that each photograph must be placed in the focal plane of a projector equipped with a lens similar to that of the field camera. The emergent beam from the projector lens will thus consist of parallel light which would only form a sharp image at infinity. To bring this beam to a focus on the screen a system of auxiliary lenses is employed (see Fig. 6, which represents a side elevation).

In order that the geometry of the machine shall be unaffected by the introduction of this auxiliary lens system, it is necessary for the axis of the latter to coincide in all positions with the line joining the screen image O'', of the point under observation, to the front nodal point S'' of the projector lens. (O'' and S'' have been lettered to correspond in Figs. 5 and 6.) It will be seen later that an approximation is made in this respect when plotting is carried out over limited areas without moving the projectors in X and Y. It remains true, however, to say that the axis of the auxiliary lens system passes through the mean point of observation and through the front nodal point of the projector lens. This condition is ensured in the following manner (see Fig. 6). The auxiliary lens system is given three motions of translation similar to the three co-ordinate motions of the corresponding projector; the girder *1* carrying the auxiliary lenses moves bodily in the Y and Z directions, while the lens system moves along this girder in the X direction. The auxiliary lens system is carried on two gimbal axes *2–3* and *4*, intersecting in the point *4* on the axis of the auxiliary lens system. By initial adjustment of the X, Y and Z motions of the auxiliary lens

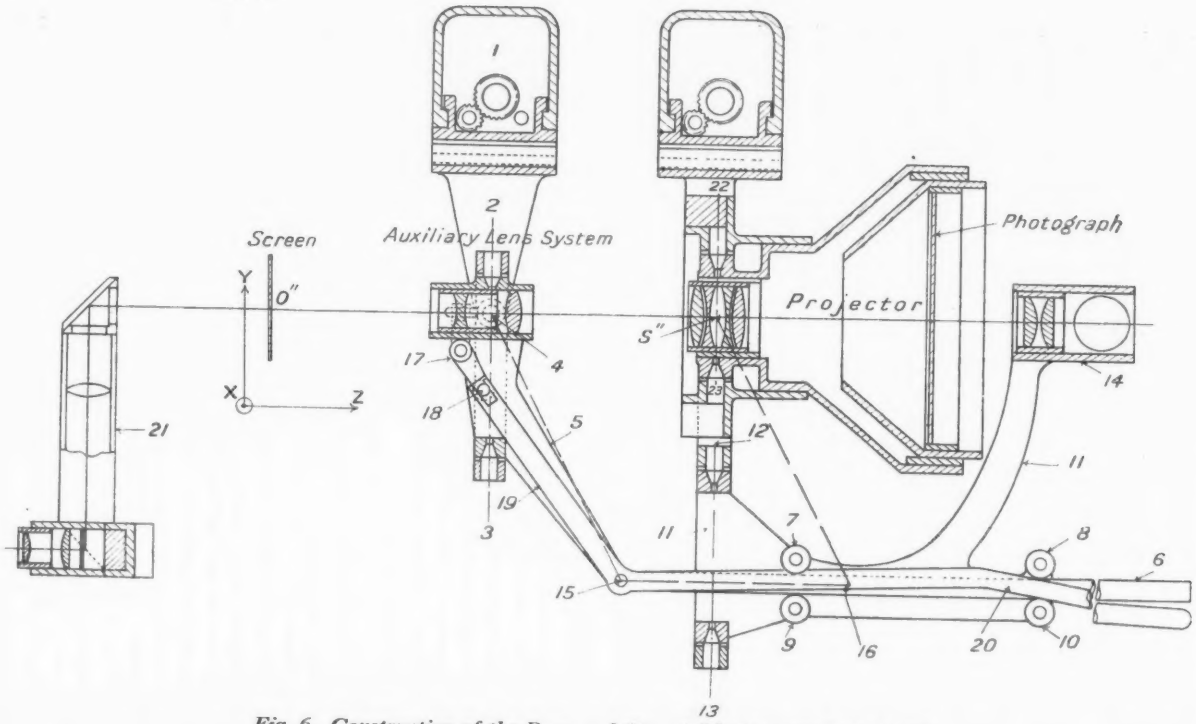


Fig. 6. Construction of the Barr and Stroud Photogrammetric Plotter

system the point *4* is brought on to the line $S''O''$ at a point midway between S'' and O''. Thereafter this relative position is maintained by imparting half the X, Y and Z motions of the projector to the corresponding movements of the auxiliary lens system. These movements of the auxiliary lens system are provided automatically through reduction gearing from the X, Y and Z controls of the projector movements.

This arrangement ensures that one particular point on the axis of the auxiliary lens system always falls on the geometrical line of sight $O''S''$. It remains necessary to rotate the axis of the auxiliary lens system about this point until it passes through the front nodal point of the projector lens, and thereafter to preserve this condition automatically for all movements of the latter. This is done by means of the arm *5*, which is rigidly coupled to the auxiliary lens system and is continued as the rod *6*. The latter slides between rollers *7*, *8*, *9* and *10*, which are fixed to the bracket *11*, carrying gimbal axes—of which *12–13* is one —intersecting in the front nodal point (S'') of the projector lens. Initially the centre line of the rod *6* is arranged parallel to $O''S''$.

Mechanically, this linkage is equivalent to a single rod rigidly connected to the auxiliary lens system and sliding in a sleeve universally jointed to S''. Its action may be explained alternatively as follows: Suppose that *15* is a point on the centre line of the rod *6* at its junction with the arm *5*. Imagine a point *16* on the centre line of *6* and rigidly associated with the frame *11* in such a manner that S''–*16* is equal and parallel to *4–15*. These two lengths clearly remain equal after any movement whatsoever of the projector or the auxiliary lens system. Moreover, since the angles S''–*16–15* and *4–15–16* always remain fixed in magnitude, S''–*16* and *4–15* are always parallel. Consequently, *15–16* is always equal and parallel to *4*–S''. Any rotation of the line of sight *4*–S'' is thus equal to the resulting rotation of the rod *6*, which is imparted through the rigid joint *15* to the axis of the auxiliary lens system.

The bracket *11* carries a condenser and lamp *14*, whose centres are initially adjusted on a continuation of the sighting ray $O''S''$. By means of the mechanism described, the centres of the condenser and lamp remain on the sighting ray $O''S''$ for all related movements of the projector and auxiliary lens system, and thus constantly illuminate the photographs in the areas under examination.

It may be admitted here and now that the mechanism described above and illustrated in Fig. 6 introduces errors, particularly in the Y direction, owing to faulty balancing. These errors do not seriously affect plan positions, as plotted, but they are too great to allow the machine to be used for setting the photographs in the machine itself on the Fourcade correspondence principle. Such an application was not, however, considered in the initial design, and the defect could easily be eliminated in subsequent models. Photographs are set in the first model from data acquired in a separate instrument—either from individual photographs in the MacLeod Tilt-Finder or from stereoscopic pairs in the Fourcade Stereogoniometer. These data are provided in both cases by marking the actual plumb points on the photographs and by recording the length and inclination of the base. But for this (avoidable) source of error in the Y-direction, the machine itself could be used for correspondence setting quite as well as any Continental machine.

It remains desirable to vary the focal length of the auxiliary lens system in

Fig. 6. Construction of the Barr and Stroud Photogrammetric Plotter

order that focus on the screen may be preserved for all variations in the distance $O''S''$ (or O''–*4*) consequent on the X, Y and Z motions of the projector. This is done by mounting the double convex component in a separate barrel provided with pins engaging in a slotted lever pivoted at *17*. The lower end of this slotted lever is provided with a pin *18* moving in a slot at the end of the lever *19*. The latter is pivoted at *15*, whence it is continued as the curved arm *20* passing over a fixed roller in front of *10*. The under side of *20* is given a definite shape which regulates its rise and fall as the distance between the projector and auxiliary lens system is varied. By means of the lever system described above, the rise and fall of *20* is transformed into an alteration of the separation between the two components of the auxiliary lens system, with an attendant variation in the focal length of the combination.

The two screen images are observed by means of a stereoscopic comparator *21*, provided with floating marks. The apparent separation of the floating marks on the screen is made equal to the "comparator base" as described above. Alternatively, the stereoscopic comparator may be replaced by a coincidence comparator in which comparison between halved images is made on the principle of the ordinary Barr and Stroud coincidence rangefinder.

So far, the description of the machine rests on the replacement in the projectors of the original photographic negatives, in which case the landscape is reconstructed true to scale and form, from the point of view of an observer looking at the screen from the position of the projectors. The effect of observation on the other side of the screen is to reverse the apparent relief of the landscape, without modifying the truth of its geometrical reconstruction, and thus to provide the unnaturally flat impression usually associated with pseudoscopic vision. This difficulty is overcome, and the natural appearance of the landscape is also increased, by using glass positives printed from the original negatives. There is no need to introduce any complicated system of optical inversion so dear to the hearts of Continental designers.

Setting Movements

To re-establish the photographs in their correct relative positions, the following movements are provided:

To re-establish the internal perspective of each photograph in relation to the projector lens, the photograph is given two motions of translation in its own plane and one motion at right angles to its own plane. The extent of these motions is determined by calibration of the field camera, and the corresponding adjustments in the machine remain fixed for use with a particular camera.

To obtain the external perspective the photograph may be rotated in its own plane, and the projector as a whole may be tilted about an axis passing through the front nodal point of the projector lens (*22–23* in Fig. 6). These two motions enable the marked plumb point of an air photograph to be brought on to the counterpart in the machine of the plumb line in Nature (that is, the perpendicular on the screen from the front nodal point of the projector lens). A further rotation of the whole projector about this plumb line allows for the external orientation of the photographic perspective. In dealing with air photographs, these latter motions of the projectors are worked until correspondence of photographic detail is secured in the vicinity of the plumb points.

4. The Fourcade Stereogoniometer

5. The Barr and Stroud Photogrammetric Plotter

In future models it will probably be advisable to replace these movements of each projector by one rotation of the photograph—in its own plane—and one tilt in each of the fixed X and Y directions. This would enable the principle of correspondence setting to be applied almost as well as in the Fourcade machine itself and far more rapidly than is possible with the involved geometry of the Continental machines. The method of setting would be approximate, but would probably attain sufficient accuracy without prolonged successive approximation—especially in the case of vertical air photographs.

One projector may be moved independently of the other in the X direction. The amount of this motion is determined by a final separation of the two projectors equal to the length of the base—to the required scale of plotting—plus the length of the "comparator base."

One projector is given an offset movement in the Z direction equal to the difference in altitude of the two air photographs—also to the required scale of plotting. A similar offset movement in the Y direction is provided for setting an inclined base in the case of ground photographs.

Similar movements, equal to half the corresponding projector movements, are imparted to the auxiliary lens systems.

X, Y and Z scales are provided to enable the relative co-ordinates of any point in observed coincidence with the comparator floating marks to be read off direct.

Mechanical Details

Such details of operation as have not been described above may best be gathered from the photograph of the actual machine reproduced in Pl. 5.

The X, Y and Z control wheels are placed on either side of the observer. Clutches are provided which enable the drawing board to be moved independently of the projectors (to set for the origin of the plot) or coupled to the X and Y (or Z) projector movements. During the plotting of air photographs the main controls are moved until a fresh patch of detail is thrown on the screen. The comparator, to which the drawing pencil is attached through an extension arm, is then moved over the screen image with the floating mark in successive contact with photographic detail which it is desired to plot. An occasional turn of the Z control is required during this process to bring the floating mark to equality in depth with the stereoscopic image, though no great accuracy is required in this respect. To trace contours, the Z control is fixed—at the required height—and the floating mark is moved in apparent stereoscopic coincidence with the ground, either by the X and Y projector controls, or—locally—by moving the comparator.

By means of two suspension wires led over pulleys and attached to the same balance weight, the comparator is prevented from rotating but is otherwise free to move in two dimensions. This motion is so well balanced that no difficulty is experienced in tracing continuous detail in two dimensions, especially as the movement of the comparator is parallel to the shape of the detail. The comparator may be moved by one hand or two, and forearm rests are provided for steadiness.

The drawing pencil can be raised out of contact with the paper, either temporarily or permanently, by means of a lever and catch placed convenient to the observer's left hand.

The screen may be moved bodily up and down by means of the screen control, and at the same time the comparator may be swung round through 180° to observe on the screen in its lower position. This device allows the whole machine to be reduced in size and yet deal with photographs considerably tilted (up to 45°) in the Y direction. Air photographs tilted more than 45° in the Y direction may be dealt with by an interchange of the Y and Z plotting movements as in the case of ground photographs.

The British soldier is in the habit of describing his tools by affectionate, if frivolous, nicknames, and as the name Big Bertha was mentioned in the discussion, it becomes necessary to add a word of explanation as to size. The actual space occupied by the machine may be gauged from Pl. 5, and admittedly exceeds that required for some Continental machines. The first model was designed according to specification for a whole range in permissible size of photographs up to 9½ in. × 7 in., and for a range in focal length up to 12 in. A 20-in. focal length, in use by the French at the time, was given up only after the main structure of the machine had been completed. The machine, moreover, was designed for every conceivable combination of tilts and base lengths, and for a wide range in plotting scales. At the time the machine was designed, no practical experience was available regarding possible limitations in these respects—the design of air cameras was, for instance, fluctuating from month to month—and there was no alternative but to make provision for every probable, or even possible, case. The penalty of increased size had accordingly to be paid, but for an experimental first model this was not considered a serious disadvantage. The conditions are very different now. Air cameras for instrumental surveys are rapidly crystallizing into a standard size of 5 in. × 5 in. × 5 in. (focal length) as a just compromise between aircraft space, weight, angular field, and the interpretable scales of photographs exposed from economic altitudes. The types of air photographs for which it is necessary to legislate could, for all foreseen practical purposes, be restricted now to verticals and pairs of lateral obliques equally tilted to 20° ± 5°. The range in plotting scales could also be considerably restricted. In these circumstances, a very much more compact and accurate machine could without the slightest doubt be constructed on this principle. There is no justification for an unfavourable comparison in this respect between other machines and the first Barr and Stroud model, with its wide range of application.

Characteristics

The chief advantages which may fairly be claimed for the Barr and Stroud machine are simplicity and ease in plotting.

The greater ease of plotting in the Barr and Stroud machine is at once apparent to any one who has worked with it and with other machines. All the observer has to do is to follow the course of detail as he sees it by a single movement which directly copies the apparent shape of that detail. If the observer sees a square or a circle he traces a square or a circle with the comparator by moving the floating marks along the outlines of the detail which it is required to plot. It is true that a certain amount of theoretical error is introduced in the process, owing to aberrations of the auxiliary lens system, but the extent of this error may be controlled at will by limiting the area traced at one setting of the pro-

jectors—thus using a principle with which all practical surveyors are fully acquainted. The projectors can at any time be moved to bring in a new area, and no accurate adjustment is needed of the amount of such motion. Contrast this with the "one-man-band" operation of other machines, in which the observer has to follow the course of detail running in any direction by compounding the independent effects of turning two handwheels, at the same time turning a wheel with his foot. I am well aware that good continuous plotting can be carried out under these latter conditions, but only as the result of prolonged training.

The drawing-board of the Barr and Stroud Plotter is placed close to the observer, who can consequently see exactly what he is doing during the process of plotting.

As regards simplicity, there are no redundant movements involving complicated cam mechanisms, and no reversals or changes in geometrical direction which oblige the observer to imagine himself turned inside out or standing on his head to obtain a clear picture of what he is doing in setting the machine. The principles and operation of the machine can be learnt in a few hours' actual work, the makers' adjustments and calibration are simple and direct, and the user's adjustments are simple and few.

It may be argued that complexity in machine construction is a matter for the designer and is no concern of the user, who does not need to understand its working thoroughly. With that view I most heartily disagree, and I base my opinion on an intensive experience of this type of machinery. Sooner or later the rule of thumb operator makes a mistake and may spend days locating it. If the machine goes out of adjustment or has to be moved, he is helpless and has to call in the maker. From the day of its delivery, the Barr and Stroud machine has been under intermittent test—much of the work being done by a draughtsman—and not once have we been compelled to call in the advice or explanation of the makers. I have yet to learn of a Continental machine being put to work at a considerable distance from the factory and without the assistance of the makers or without personnel specially trained by the makers.

DISCUSSION

Before the paper the PRESIDENT (Colonel Sir CHARLES CLOSE) said: Captain Hotine has very kindly consented to give us a paper on "The Application of Stereoscopic Photography to Mapping." We are all, in a general way, acquainted with what is going on in the direction of stereoscopic mapping, but it is not everybody who has had actual practice in the matter. All these new methods, which are extraordinarily fascinating in themselves, will ultimately depend upon their value in cheapening surveys. I think, of course, there are some instances in which stereophotogrammetric methods will be used whether they are cheap or not, because they may be the only methods available for that particular problem, but in general we expect that these methods will have to justify themselves financially. I will not say any more about that point now, but ask Captain Hotine to begin his lecture.

Captain Hotine then delivered the lecture printed above, and a discussion followed.

The PRESIDENT: Captain Hotine is serving with the Geographical Section of the General Staff under Colonel MacLeod. We shall be glad if Colonel MacLeod will say a few words.

Colonel MACLEOD: Before making any comments on the paper I would like to pay a tribute to the work which Captain Hotine has done on this subject. I think I can claim to be as well qualified to do that as anybody, because now I am the only member of the Air Survey Committee, which deals with this matter, who has served on that Committee since its inception, and I can recall our ideas on this subject when Captain Hotine joined the Committee. We had talked a good deal and we had made a number of suggestions and discussed them, but when it came to actually doing a job of work, we were, as the story goes, all of a-tremble; we did not seem to be able to get on at all. I would not have you think that we achieved nothing: that would be doing us an injustice. After the war we on that Committee not only had to get our theoretical ideas in order but we also had to devise and get constructed apparatus with which to carry them out. That naturally took time and cost a good deal of money, but for the most part it did eventually materialize.

The first thing we wanted in order to progress with this subject was a properly calibrated camera. That we had not got, to start with, but ultimately we did get it, thanks largely to Wing-Commander Laws, who is with us this evening. After that we had to get plotting machines of various kinds, and the production of these instruments was the first task the Committee had to tackle. Though we got these things made, I think we must now admit that we really did not do very much more than "clear the ground"; indeed, the uncharitable might say that we left a good deal of junk lying about on it. However, I think much of it was useful junk, and when Captain Hotine came along he was able to pick out the useful bits, cement them together with ideas of his own, and produce the working system which he has described to us and the products of which are on the screens in this room. It is a working system which has, on the occasions we have tried it, given surprisingly good results.

Looking back, I cannot help thinking that one of the reasons why we made such poor progress was that our experience in France actually misled us. As you know, in France we were engaged in producing maps from air photographs, but we hardly realized that we were dealing with a special case. We dealt there with the individual photograph, and after the war when we had to solve a more generalized problem we tried to do so by methods which had served us in France: in other words, by working on the individual photograph. It was Captain Hotine who brought home to us that the "unit" as regards air photographic mapping is the overlap—the stereoscopic pair—not the single photo.

I have to plead guilty to having, at a meeting of this Society, belittled the stereoscopic principle on the ground of the restriction thereby imposed on the length of the base; I thought that it was not taking the fullest advantage of the mobility of the aeroplane. Mr. Fourcade and Captain Hotine have shown us how to get over that difficulty, and though after my former failure it may be a little rash for me to venture another prophecy, I am now satisfied that it is on the stereoscopic principle that the future of air surveys will rest.

A word about the stereoscope. I do not expect many of you have used it. Some people are, I think, at first inclined to distrust the stereoscope as an instrument of precise measurement. There seems to be altogether too much scope for judgment in using it; in fact, one is apt to think that with an instrument of that sort in the hands of a man who is not thoroughly trustworthy, judgment may very easily degenerate into "fudgment," and that, as you know, is the surveyor's most heinous crime. Actually I think that is not so. Captain Hotine will bear me out when I say that with practice soon comes a confidence in the stereoscope which is amply justified by results.

Before sitting down I would like to add, with reference to the President's

remarks on the economic aspect of this matter, that of course there is another aspect which I in my official capacity am concerned with, namely, the military aspect. I personally regard the perfection of air photographic survey methods as a scientific development whose military importance can hardly be exaggerated. I think that when it is well understood and properly exploited it will put into the hands of the civilized and educated man a weapon—or rather, a method of fighting—which will prove perhaps more effective even than the armoured vehicles that now loom so large in the public eye. It would require a good deal of explanation to say why that is so, and there is no opportunity for me to go into that here, but I believe that statement will prove correct, and, what is more, I believe that this method of fighting will be particularly valuable because it is one which the illiterate and the savage cannot use.

Brigadier E. M. JACK: I would like to ask one question. How long did the setting of the photographs recorded take?

Captain HOTINE: The first pair took a whole day; the second pair three-quarters of an hour. We have not tried the third pair yet, but I think we shall be able to cut down.

Brigadier JACK: The only other thing I would like to do is to express the very great interest with which I have heard Captain Hotine's paper and to congratulate him on the lucidity and clearness with which he delivered it. It really was delightful.

The PRESIDENT: I will ask Mr. Hinks if he will kindly say a few words on the subject, which he has studied a good deal.

Mr. HINKS: I should like to express my great pleasure at having heard this paper, and equally my great gratification that we shall be able to publish in the *Geographical Journal*, in the course of two or three months, some description of methods that many of us have wanted to know about for a long time and now, for the first time, have the opportunity of judging. There has been, we have heard, a mysterious creature which has been kept somewhere in the War Office, which is known, I believe, by the name of "Big Bertha," and I am interested, first, to note that Captain Hotine speaks of her—the Barr & Stroud machine—as "superior in conception and vastly simpler than any Continental model." That, of course, is a very strong compliment to Big Bertha, but it clearly necessitates that we should be able to have her portrait and, I hope, a description of her constitution published in order to judge of the merits of the statement. I think I am right in saying that at present nobody, except one or two in the War Office, knows anything about the optical design of Big Bertha or the geometry of the method. I feel that now we have been told it is "superior in conception and vastly simpler than any Continental model" we are justified in expecting this secret to be at any rate partially revealed. We have heard first in this Society of the Stereoautograph and the Hugershoff machine, and more recently, after Major Kenneth Mason had made that very successful photographic survey in the Shaksgam, we had some account of the Wild machine. While Major Mason was actually measuring the plates I was trying to write out the geometry of the thing, and we had a joint paper on the subject. Captain Hotine spoke rather scornfully of the modification by which Wild has made a patchwork of a machine originally designed to work upon the ground. I venture, with all deference to Captain Hotine, to maintain that that is not quite fair. The machine of Wild was originally designed to work either upon the ground or from air photographs. It is perfectly true that Wild found that as soon as he had given an additional motion to the machine he could make it easier to work on air photographs, but I do not think it is just to him to call it a " patchwork system in a machine originally designed to work upon the ground." I am interested to know that Captain Hotine considers, even when

that system has been patched up, its geometry is not as successful as that of the Fourcade machine. I asked Captain Hotine—I hope he will accede to my request—to write a page or so in the *Journal* explaining exactly what the geometry of Wild's modification is and how it is that it breaks down. My own account of the machine was written before the latest modification, and although I saw the machine in July at the Aircraft Exhibition at Olympia I am bound to say I did not in the least understand the modification.

The second point that I should like to emphasize is that, if I understood correctly—and I shall be glad to be assured on this point—the Fourcade machine, which was also built by Barr & Stroud, is a very fine solution of the problem of the duplex tilt-finder, and its duplicity—in the good sense—enables one to put together pairs alternately and so step along a long traverse. Colonel MacLeod developed several forms of tilt-finder in the early days of the Air Survey Committee. It is, of course, as Captain Hotine says, possible to add a plotter—that is possible with any machine, though rather a heavy job sometimes—and it will be interesting when he has been able to realize it.

There are many things one might say in discussing this fascinating subject, but I will say only one more. Captain Hotine warned us—I do not know whether he was referring to me in particular—off academic optical objections to his theory. In spite of that warning I would like to remark that at present all the diagrams I have ever seen explaining the optics of this machine show optical rays converging from a pair of eyes towards a plate. I do not say that that way of drawing the thing is necessary to the explanation, but it certainly seems to be involved in the explanation, and it also seems to me to be plainly false, because there is no question whatever that in any of these stereoplotting machines the axes of the eyes are governed by lines between the optical centres of the eyepieces and the floating marks, and in order to keep those floating marks fused the eyes must remain parallel. There is no doubt about it that the idea that the eyes converge to get these optical effects is totally wrong. I do not say that is the explanation always given, but it is too often given. There is something very much more occult and mysterious about it than mere convergence of the eye. I think Captain Hotine will agree.

Captain HOTINE: I will answer the question, but I do not promise to agree.

Wing-Commander LAWS: I am not sure that I can contribute anything useful to the discussion. I have only dealt with the air side of the problem. It might be of interest, however, for me to say that any air work called for in connection with the making of these various maps has not presented any problem which could not be overcome by any reasonably well-trained pilot. That seems to me to be important from both the Service and commercial points of view. I would say that any scheme produced which necessitated the employment of a pilot highly skilled in surveying would be a failure from a Service point of view. I can assure you that the method described by Captain Hotine does not require any special knowledge. We are satisfied that under normal conditions we can meet the requirements.

Captain KEMP: I am afraid I have nothing very useful to add, but I would like to congratulate Captain Hotine on his very clear and interesting paper, and to say that I hope Colonel MacLeod's views can be forced upon the authorities so that the Committee may have better funds in future.

Major COCHRAN-PATRICK: The President has stressed the point of economy in air surveys and Colonel MacLeod has shown the importance of the military side, but there is one aspect which is really even more important and which has not been touched upon, and that is the question of speed. By using air surveys we have enormously hastened the whole operation of mapping. To digress for a

second from the topographical scales mentioned in the paper, I might cite a point that has come up in a recent survey of Rio. We have only one equivalent survey with which we can compare it, and that is the survey of Berlin. We have heard from our manager in Rio that he has completed in one and a half years a job equivalent to one which took twenty-two years in Berlin. That is on the scale of 1/1000. We were definitely using ground methods supplemented by air photography; there was no question of stereoplotting instruments. Where we gained, of course, was on account of the fact that we did not have to force our way into backyards and get access to private property. We find that actually the amount of checking on the ground which has to be done in the detail work is surprisingly small.

Captain Hotine has said a great deal about the various instruments which were produced in the early stages, but he has really said very little of the instruments which he has been mainly responsible for producing and which, of course, are applicable to the smaller topographical scales. I should like to pay a tribute to his ingenuity in originating the idea of the parallactic grid and in producing in this practical manner a two-dimensional instrument instead of the three-dimensional machines with which we had been trying to compete. We in our company have used those topographical stereoscopes of his a great deal and have had much practice with them; we find everything he claims works out absolutely exactly. In fact, the only alterations which we have had to make are in detail operations. For instance, in the drawing on of contours we find that the average draughtsman is not particularly good at lifting a grid and drawing a contour on the photograph underneath, so that it is simpler, in spite of the extra expense, for us to make glass positives, put the grids under them and draw the contours directly on to the positive without interfering with the grid at all and, in fact, while looking at the grid. I should like to thank Captain Hotine very much for his paper.

Mr. G. T. McCaw: I should like to follow up the preliminary remarks with which you, sir, opened the meeting. Omitting military and some special requirements, I would refer to-night to the economic adaptation of air photography to civil ends. Of the numerous inquiries which have come before the Air Survey Committee, none has been more insistent in peace than the question of cost. In this matter there has been a gradual evolution of thought and method—as indeed Colonel MacLeod has already hinted. Starting with the individual photograph, we began by thinking of the means of bringing it into terms of ground controls. The process was not simple. Faced with this difficulty, we were forced to the conclusion that the application of such methods would damn for ever the employment of air photography in an economic sphere.

There was in existence, however, though in rather crude form, the graphical method of radial-line plotting. In the hands of Captain Hotine the method was developed, chiefly by the adaptation of a simple stereoscope to the improvement of the orientation and spacing of photographs taken throughout a strip flight, and by the invention of a transparent grid to gain sufficient knowledge of relative heights. This "Arundel" method in skilled hands proved rapid and inexpensive, while giving the accuracy required for topographical maps on common scales. For more accurate work on large scales and for mechanical plotting, the difficulty remained practically unsolved until Mr. H. G. Fourcade—one of the earliest workers in photogrammetry—came forward with the Correspondence Machine which we have named the Stereogoniometer.

In both the graphical and mechanical methods mentioned there is a common fundamental principle—that of utilizing the correspondence between overlapping photographs of a strip to set up their own control. This process is, of course, not continued indefinitely, but it is continued far enough to remove air survey

from the academic to the economic sphere. Mapping from aloft would never have made headway had the fundamental principle not been accepted that, since it is economically impossible to fix ground controls for every photograph, air survey, to be economical, must be to a certain extent, as it were, self-supporting. That it can be so has been the text of the lecture to-night.

Mr. M. A. SPENDER: I wonder whether there would be any chance of bringing this method down to earth again. It has always struck me that the trouble with the Wild instrument is that you have to know far too much. You have to know enough about the base conditions to tell you everything, and then you have to have the three controls to set the instrument. Is it possible to have a method of control whereby the photographs are their own control—to simplify the whole thing and bring the ground pairs together mechanically into line with the air pairs?

Captain HOTINE: As regards bringing the whole system down to earth again, that is, I assume, the question of making photographs produce their own control, that is what we are hoping to do with the new Fourcade machine. Major Cochran-Patrick has remarked that a glass positive might be used in the Topographical Stereoscope so as to avoid having to lift up the grid plates to draw contours. That instrument was designed primarily for military purposes, and whereas we can always get hold of a paper print and be relied upon not to break it, the same does not apply to a glass positive. I think he may be right in adapting the instrument to the use of glass positives for his own purposes. I do not think we ourselves would be justified in doing so. The draughtsmen in the Geographical Section of the War Office have little or no difficulty in this respect. They get quite used to lifting the grid with one hand and working with the pencil in the other. There is no reason why a draughtsman should not occasionally remember that he has two hands and that both are available.

Major Cochran-Patrick also spoke of speed. On that question I agree with him as regards the speed of plotting on larger scales, but I disagree when it is a question of small scales and open country. If you are out, for instance, to produce a $\frac{1}{4}$-inch map of open country, and assuming you are able to spend the large amount of money required for air photography in hiring a correspondingly large number of plane-tablers, then I have not the least doubt that this army of plane-tablers would beat the aeroplane every time. But, of course, the crucial point is that there is no army of plane-tablers available, not even a British army.

As to Mr. Hinks' objection to my criticism of the modification of the Wild instrument, Wild had originally arranged that photographs exposed in any way, even horizontally or vertically, *could* be set in the instrument, but he had omitted to consider *how* he was going to set them. It was the setting of the instrument which necessitated the patchwork arrangement—an expression to which I still adhere. In fact, if Mr. Hinks will agree that it is necessary to set photographs before one can plot them, I think he will agree that the original criticism holds.

Mr. HINKS: Of course Wild originally intended to make a separate tilt-finder.

Captain HOTINE: Yes, but he did not do so.

Mr. HINKS: No, but he did the other thing instead.

Captain HOTINE: Yes, by patchwork—an afterthought. I think I can promise a description of that elusive lady, "Big Bertha." When I say that the instrument is superior in general conception I really mean it. It is the only instrument of its kind in which you can see clearly what you are doing in setting and what you are plotting. I think those are two very considerable advantages which justify its superiority in conception. That other merit of simplicity can only be justified by a full description of the machine.

I think the only other point I have to answer is Mr. Hinks' question as to a large convergence of the eyes. I should like, first, to say that it is quite true that when you are examining any objects stereoscopically you do not wilfully converge the eyes to the extent shown in the diagram. It would be uncomfortable to do so. But we have to keep such diagrams within the compass of a lantern slide or a piece of paper, and consequently we cannot make the diagram disproportionately large in order to make it look more natural. That, I feel, is not exactly Mr. Hinks' objection; he rather claims that in most stereoscopic machines the actual condition is that the axes of the eyes are not converged at all but are parallel. That, I think, is wrong; certainly in every stereoscopic machine I have examined. The two floating marks are usually fixed in most stereoscopic machines, and they are designed for a certain convergence of the eyes, either by decentring the floating marks or by increasing the interocular distance setting. Otherwise, in cases where two corresponding points of photographic detail are at a greater separation than the floating marks and tend to form an image at a farther distance, the eyes would necessarily have to diverge in order to fuse them.

Mr. HINKS: If you had the eyes directed on those objects. I think you keep the axes of the eyes upon the marks and, by some peculiar process you do not understand, do the fusing; you get the impression of the stereoscopic views round about the floating marks, keeping the axes of the eyes fixed on the marks.

Captain HOTINE: I think you first of all fix the marks and then fix the ground in rapid succession.

Mr. HINKS: I do not think so.

Captain HOTINE: It is perhaps a matter of opinion. The movement is too rapid for one to be conscious of, but I imagine I have given the explanation. In any case it is usual in stereoscopic machines to allow a certain convergence on the floating marks so as not to have any uncomfortable feeling of divergence.

Mr. HINKS: Perhaps I should have said the axes of the eyes remain fixed rather than parallel. The floating marks are fixed and you keep the axes of the eyes fixed—not perhaps strictly parallel, but fixed. It is not a question of altering the convergence of the eyes to get the stereoscopic effect.

Captain HOTINE: I agree that it is *possible* to compare the stereoscopic depths of objects lying within the field of distinct vision without altering the convergence of the axes of the eyes. Experiments made under the instantaneous illumination of an electric spark, when the eyes have no time to alter their state of convergence, have proved this. I do not, however, believe that a sufficiently acute observation can be made under such conditions. In comparing two objects, is it not reasonable actually to look at each in turn? If the two objects are at different depths, looking at them entails an alteration in convergence. In training stereoscopic observers, we find that a common fault is to concentrate too much on the marks, as you are suggesting, and too little on the ground. We get them out of that habit as soon as possible by telling them to concentrate on the ground and ignore the marks. The latter have a strong enough stereoscopic character to force attention, and in the result the observer arrives at the correct state of balance between the two. To concentrate on the marks and ignore the ground, thereby retaining a fixed state of convergence, is roughly equivalent, to use a monocular parallel, to concentrating on the foresight and neglecting the target.

Mr. HINKS: The explanation, I think, lies far deeper than one can go with geometrical optics. We cannot explain by what process in the brain the separate and slightly different images formed by the two eyes in ordinary use are fused into one picture with the sense of solidity; but there is much more in

it than any simple question of variable convergence, and I would maintain that we should accept it as a mysterious physiological fact and not attempt to explain it by geometry.

The PRESIDENT: Captain Hotine at the commencement of his admirable paper described how in the early days one was apt to mistake a hill on two photographs. I am afraid that even the plane-tabler does that sometimes. I remember in 1890 in Burma I was given a reconnaissance map made by a staff officer in which appeared a magnificent 5000-feet hill. When I came near the ground I found the hill non-existent; he had his two rays and had identified them wrongly. That might happen to anybody, even to a photographer. I was struck by the progress that has been made in the stereoscopic method. I remember when Mr. McCaw was in Fiji he took some stereoscopic photographs and sent them to Southampton, and we had the pleasure of trying to make a map from them. It was excessively difficult. In those days we used Major F. V. Thompson's machine, and it was difficult to get any sort of coincidence.

Mr. MCCAW: Of course there were special difficulties in Fiji.

The PRESIDENT: But the progress has been very great. In reading up this subject I am struck with the difficulty of remembering the names given to these various machines. We have stereocartograph, autocartograph, photocartograph, and stereoplanigraph. It is hard to remember which machine you are dealing with. I wish some simpler form of nomenclature could be devised.

We are glad to hear from Captain Hotine that the British machine has the merit of simplicity. The general outcome of this sort of work is that we shall tend to employ, in future, a few skilled men as opposed to a large number of relatively unskilled men. We congratulate Captain Hotine on the development of the parallactic grid, and are very grateful to him for the paper he has given us. I know you will show your appreciation in the usual way.

HIMALAYAN NOTES

I. *Identification of Karakoram peaks by the stereoscope*

MAJOR Kenneth Mason sends us tracings of two panoramas, F and I in Dr. De Filippi's 'Karakoram and Western Himalaya,' taken respectively from the ridge east of the Sella Pass, and from the southern ridge of Staircase Peak, and looking eastward over the Shaksgam valley to the country which he surveyed with the photo-theodolite in 1926. By a study of his pairs of photographs in the stereoscope he has been able to identify with certainty a large number of features in the panoramas taken on the Abruzzi expedition, and he remarks that without the stereoscope these identifications were not possible, while with it they were fairly obvious.

II. *An unpublished report on Hunza glaciers*

We are indebted also to Major Mason for a copy of a report on Hunza glaciers, made by Captain F. H. Bridges in 1908, which has remained unregarded in the records of the Political Officer at Gilgit for some twenty years. It

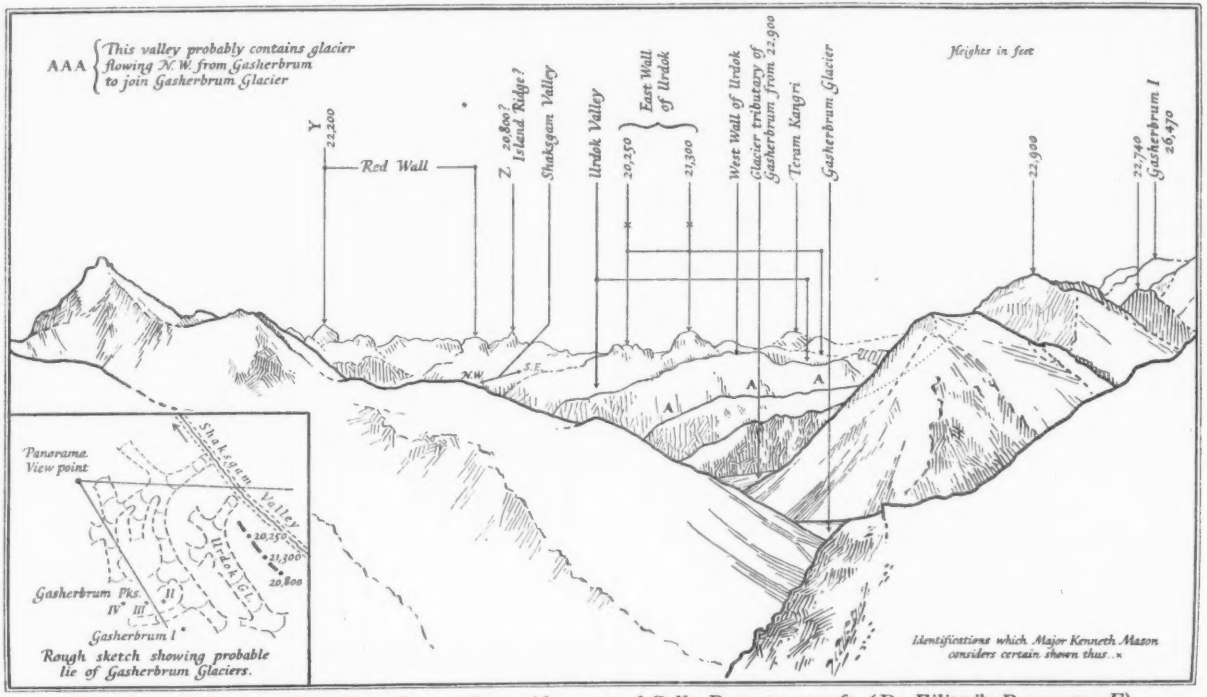
will be remembered that in 1892 Brig.-Gen. Sir George (then Lieutenant) Cockerill made a reconnaissance of the Shingshal Valley, with the particular object of reaching the Shingshal Pass from the west and joining up with the reconnaissance to this pass from the east made by Lieut. Younghusband in 1897. Four miles above the village of Shingshal he reported a large glacier which is the Yazghil, but for which he obtained the name Verigerab, and just below its snout he turned north-eastward up the nullah which comes down from the pass, leaving the upper part of the main valley unexplored. His report on this journey remained in the confidential records of the Political Department for thirty years, until in 1922 he obtained permission to publish the paper in the *Journal*, vol. 60, p. 97, Aug. 1922, calling attention to a most interesting region which had, it seemed, never been visited by any European since 1892.

When Mr. and Mrs. Visser planned their Karakoram expedition of 1925 they resolved to follow up this pioneer work of Lieut. Cockerill, and two marches beyond the village of Shingshal they "made the exciting discovery of an immense glacier region which was quite unknown." Three immense glaciers, the Virjerab, Khurdopin, and Yukshin-Gardan, were explored by them and mapped by Afraz Ghul Khan (*G.J.*, 68, 457, Dec. 1926); and Mr. Visser came to the conclusion that the floods which from time to time devastate the valley are caused by the Khurdopin advancing and blocking the valley.

It now appears that this question had been investigated in 1908 by Captain F. H. Bridges and a little later by a surveyor detailed by the District Engineer. Thanks to the stimulus of the Himalayan Club the report has now been disinterred from the Gilgit records, and the greater part is printed below. The three glaciers which we first learned of from the Visser expedition are laid down on the sketch-map accompanying the report, and four sketches of the glaciers accompany it, of which copies are now in the Society's collection. Captain Bridges made no attempt to ascend the glaciers; his business was to study the cause of the occasional floods, and to provide for better future observation he established marks to serve as flood gauges, for the use of the watchers sent each summer by the Mir of Hunza. One may hope that some results came of this enterprise, and that further search in the Gilgit records, or inquiry of the Mir, may produce details of floods and heights of the temporary lakes.

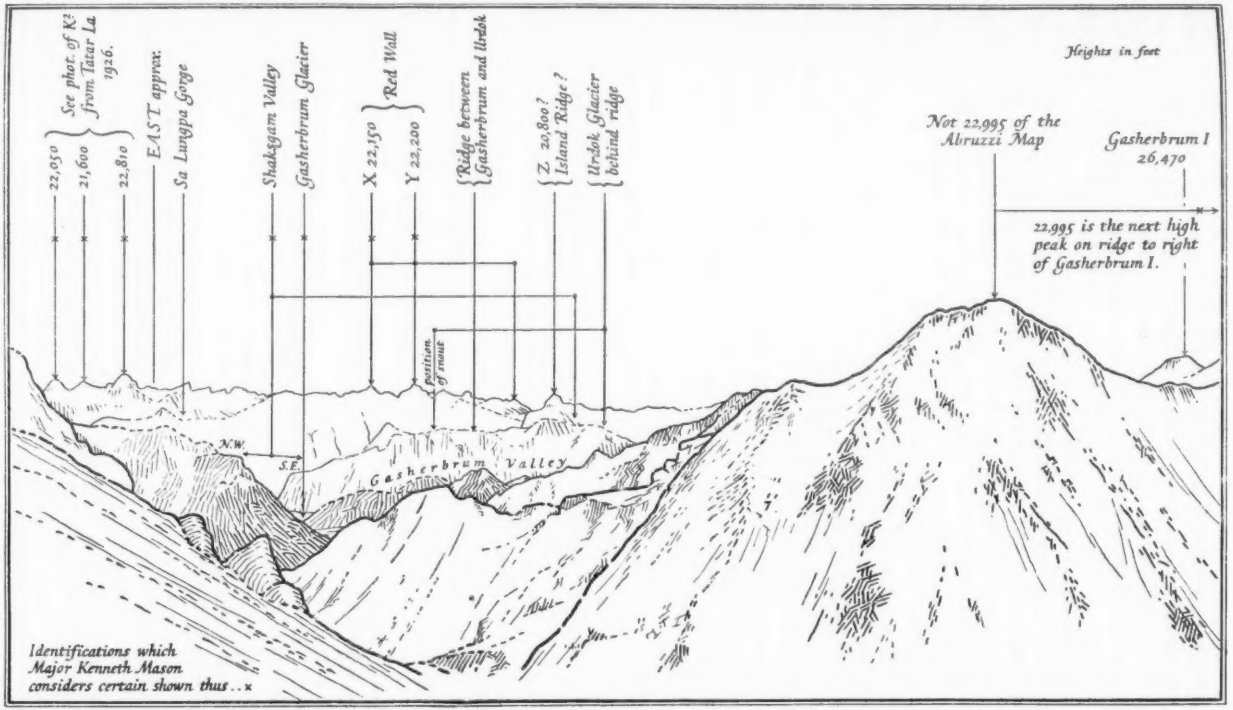
Captain Bridges writes Yarsghil for Yazghil, Kurdarpin for Khurdopin, Vergerap for Virjerab, and Shungdickt (or Shungdiekt on the sketch-map) for Yukshin-Gardan of the surveys of Afraz Ghul Khan. His report for the region above Shingshal village is as follows:

On the 24th [April 1908] we moved camp up to the big glacier, which is about 8 miles from Shingshal. About 2 miles beyond the mouth of the Shugerab nullah is the Yarsghil Glacier, shown in error on the map as the Vergerap. This glacier is said to be about 8 miles long. It divides into two before reaching the river-bed, being split up by a hill in the mouth of the nullah. The two snouts of the glacier are about $\frac{3}{4}$ mile apart. The nullah-bed opposite the glacier is narrow, varying from about 10 yards to about 80 yards. Opposite the upper snout of the glacier is rock, from 100 feet to 200 feet high, and above that conglomerate pari. This snout is 48 yards from the opposite cliff. The snout of the lower half of the glacier is now only about 10



Panorama looking south and south-east from ridge east of Sella Pass, 20,000 ft. (De Filippi's Panorama F)

Panorama looking south and south-east from Ridge east of Bella Pass, 20,000 ft. (De Fillippi's Panorama II)



Panorama from southern ridge of Staircase Peak, 21,627 ft. (De Fillippi's Panorama I)

yards from the hill opposite, which is conglomerate pari. The stream from the glacier is at present issuing from the upper snout.

It is difficult to gauge the amount of water now issuing from the glacier, as it issues in several streams; but the local men tell me all these streams are unfordable in the summer, so the amount of water must be considerable. The upper half of the glacier must be about 1000 yards wide, and the lower half about 500 yards; but in both cases the greater part is curved well back and has not advanced parallel with the snout. I placed three pillars at 50-feet interval in height opposite both snouts, and told the surveyor to put up a fourth both here and at Malunguti, so as to be able to register 200 feet. The lower snout of the glacier closed into the opposite bank last year; but the water ran all the time underneath. When the big glacier burst, it cut away the Yarsghil bund also. If the upper snout moves forward and piles up against the rocks opposite, a very serious bund will be formed and the nullah-bed between Yarsghil and the big glacier will be enclosed. The nullah-bed is about 1¼ miles long and 1 mile wide. It is dry at present, as the water from the nullahs above is running into the lake formed by the big glacier.

Above the Yarsghil glacier the valley opens out, and is about 1 mile broad for the next 1½ miles, and then widens out to 1½ to 2 miles across. About 5 miles above Yarsghil the valley divides into three nullahs: Vergerap, Khurdarpin, and Shungdickt.

Of these, Shungdickt is a small short nullah about a mile or two in length, while the other two extend for an unknown distance. At various times men have been sent by the Mir of Hunza to try and penetrate to their head; but have always returned unsuccessful. One levy, by name Murad Beg, who accompanied me, had been four marches into both of them during the time of Rajah Ghazan Khan. He said he could see no signs of the heads of the nullahs, and returned, as he had finished his rations.

The Khurdarpin and Shungdickt glaciers have swept down through their own nullah-beds, and meeting in the main nullah, have gradually moved on down till they now extend in one huge glacier, filling the entire main nullah-bed for a distance of about 2 miles below the mouth of the Vergerap nullah, and within about 16 miles of the upper snout of Yarsghil. The Vergerap Glacier, on the other hand, has remained stationary, and is still about 3 miles [1·6 miles according to the surveyor] away from the mouth of the Vergerap nullah. The united glaciers of Khurdarpin and Shungdickt, sweeping past the mouth of Vergerap, and impinging along the whole cliff face below Vergerap for about 1½ miles, have enclosed a large open space at the mouth of the Vergerap nullah, and it is in this space that the lake gradually collects.

I went to the edge of the dam, overlooking the above space. It is difficult to estimate its size accurately, looking down on it like this; but, I should say roughly, it extends for 3 or 4 miles in length, and varies in width from 100 to 300 yards at its base, and would, of course, increase in width as the water rose. [The area enclosed extends from the dam up to the snout of the Vergerap Glacier (Survey Sheet, No. 3), length 2 miles, mean width 1 mile.—*Surveyor.*] At present there is water in it for about a mile in length; but it is impossible to make any accurate estimate of its depth. The local men estimate its present depth at the lower end at about 20 or 30 feet. Some of the Hunza men got

down by ropes to the lake to try and measure the depth; but had to abandon the attempt, owing to falling rocks and debris. [The depth measured at the upper end of the lake (see Survey Sheet, No. 3) was 25 feet. The ground has a fall of 2·6 feet per cent. The depth at the lower end of the lake would therefore be about 150 feet.—*Surveyor*.]

I could see the water-line of last year's flood on the rocks, and should say that the water did not reach a greater height than 200 feet, though this is a rough guess, as, without proper surveying instruments, it is impossible to make an accurate estimate. The surveyor, however, sent up by the D.E., will be able to do this. [According to mark pointed out by the local people, the water rose 140 feet above present water-level in the lake.] The water in the lake, I am told by the local men, stretched as far back as the snout of the Vergerap Glacier last year, and I could see the water-line on the rocks in the Vergerap nullah. The water, according to the reports of the men told off to watch it, rose last year till it overflowed the top of the glacier, where it impinges on the right bank, and then cuts its way clean through the glacier. This is undoubtedly true. There is an enormous channel, about 150 feet deep and 80 to 100 feet wide [mean width, 50 feet], cut clean through the ice, like a huge canal, at the lower end of the lake. This has water in it now. I went to the edge of it and looked down into it, and have told the surveyor to go to the same place and measure the depth of the water with a plumb line. This canal is closed by an ice-dam now, lower down. This dam is, I should say, roughly about ½ a mile, or perhaps a little less, from the outlet from the lake. It is impossible to find out what is the nature of the glacier between this dam and the snout along the right bank. Last year's flood has broken up the glacier a good deal, and left enormous crevasses all along its right bank, and, consequently, it is impossible to reach this part. One of the Hunza men managed with difficulty to reach a spot from which he could see the dam blocking the canal, but could get no farther. From questioning him, I should say it was about 100 feet above the present water-level. The water breaking through last year has caused the whole of the glacier on the right bank to sink a good deal. The centre has remained much higher, but both on the right and left banks of the nullah the glacier is at a much lower level. I examined the snout of the glacier where it impinges on the right bank, and found no sign of an outlet. There was a perpendicular wall of ice with no apparent fissures about 100 or 150 feet from the nullah-bed across last year's outlet, which is now closed. The distance between the snout near the right bank and the ice-dam in the canal is, I should think, roughly about ¾ of a mile. My camp was in the nullah within 200 yards of the snout of the glacier. My aneroid showed a rise of 800 feet from my camp to the highest point in the centre of the glacier between my camp and the lake. The distance from my camp to the lake was, I should say, about 2 miles.

Unless the glacier moves forward again and, piling up against the hill, closes last year's channel, I should say that the lake will not rise as high as it did last year, as all the local men agree that last year's bund was a good deal higher. There is, on the other hand, the danger of the bund this year suddenly bursting, when the lake is full, instead of the water gradually cutting a way as it did last year. The water last year from the lake took eleven days to empty; hence the small rise of water. I placed three pillars of stones in a line, close to the present

canal, so that the surveyor, while working there, can watch them, and see if the glacier is closing in on the canal. The local men tell me that the channel is narrower now than it was after the flood last year. Water from all three nullahs frequently empties into the lake, according to the local men. At present there is water from both the Vergerap and Khurdarpin nullahs running into the lake. Water from these nullahs runs all the year round; but in the winter the streams are small. In the summer the Vergerap stream, I am told, is bigger than the Shingshal River between Passu and Dikat, which means a considerable volume of water, as the latter is unfordable in summer and even now is 3½ feet deep in places, and about 8 yards wide. In the big flood three years ago, the flood took much the same course as it did last year; but the bund was higher then.

In the flood that took place about four years ago, which destroyed a great deal of the Shingshal cultivation, the flood came down the left bank of the nullah, having worked its way under the glacier. The second flood which came down last year in September was caused by the Malunguti Glacier blocking the stream, and not by the Khurdarpin lake at all, which at that time was empty.

At present there is no water issuing from the glacier, except a few small streams caused by thawing on the surface. I think the lake ought certainly to be watched again this year. Information should also be sent at once to the D.E. if either the Yarsghil or Malunguti Glaciers block the nullah, and a lake forms behind them.

I was accompanied the whole way by Wazir Humayun of Hunza, who made the most excellent arrangements for me. I was shown all the arrangements which were made last year to give information to Baltit when the flood was coming. Great trouble appears to have been taken over this by Wazir Humayun and the Shingshal people. There were thirty-one different posts of three men each out on the hilltops, day and night, for twenty-three days. The arrangements were that, if the flood came at night, beacon-fires were to be lit, and if it came by day, shots were to be fired.

In case the D.E. wishes to ask any questions at any time from local men, I would recommend Levy Murad Beg of Shingshal being sent for, who has watched the glacier for years. The arrangements last year were made by Trungfa Kalandari of Hyderabad, who was specially deputed for this work.

On the march back, a good deal of difficulty was experienced at two of the fords, between Dikat and Passu, on April 29, as the river had risen and was 3½ feet deep, with a very strong current. The coolies, however, managed to get across with the aid of ropes, and there were no accidents, though a certain amount of the baggage got very wet.

I did not have any difficult work climbing, the fords being the only difficulty on the road. Wazir Humayan tells me that once the river between Passu and Dikat has become unfordable there is no possible way down this part of the valley, even for the local men, and they have to go round over the Karan Pir to Gircha.

THE NAMING OF MOUNT HOOD

WE have received through the Secretary of State for Foreign Affairs a pamphlet describing the dedication of a tablet commemorating the naming of Mount Hood on 30 October 1792 by Lieutenant W. R. Broughton, R.N. Some years ago the Trail Seekers Council applied to the British Government through their Consul at Portland, Oregon, for a copy of the original of Lieutenant Broughton's Field Notes. These had not survived, but a photograph of the original chart was forwarded by the Admiralty, who arranged that the unveiling of the Tablet, now erected inside the Vista House at Crown Point, on the Columbia River, should coincide with a visit of H.M.S. *Colombo* to the neighbourhood so that Captain C. C. Dobson, V.C., D.S.O., R.N., and a small party of men of that ship represented the British Navy at the ceremony on 24 August 1929.

The pamphlet on the Naming of Mount Hood recalls that the first white man to enter the Columbia River was Captain Robert Gray, of Boston, on 11 May 1792, and that five months later Lieutenant William Robert Broughton, R.N., in command of H.M.S. *Chatham* of the Vancouver squadron, made a survey of the river with a launch and cutter. Full details from the work of Captain Vancouver and a portion of the log of the *Chatham* are given by Mr. J. Neilson Barry of Portland in a paper entitled "Broughton on the Columbia in 1792," published in the *Oregon Historical Quarterly* for 1926. From a point on the northern bank, which was the most easterly point of his survey, Lieutenant Broughton took bearings upon a "sandy point on the opposite shore," which he named after Captain Vancouver, and the same remarkable mountain which had been seen from Belle Vue Point he named after Lord Hood. Here he raised the British Flag and "took possession of the country." The Memorial tablet unveiled in the Vista House at Crown Point shows in relief Lieutenant Broughton's party pointing to Mount Hood.

The curious circumstance is that no published official map or chart shows either Crown Point or Vancouver Point, though Crown Point is shown on an unofficial railway map.

In a list of synonyms given by Mr. J. Neilson Barry in his paper of 1926 we find that Point Vancouver is now Lawton Creek Point, and from a letter to the Admiralty of 23 November 1928, kindly communicated by the Hydrographer, we extract the following particulars:

The sand bank which Broughton named is a gravel bank, where a small creek enters the Columbia, and since it is covered with water except at the season in which Broughton made his survey, it required much study and many explorations of the neighbourhood before the exact point could be absolutely identified.

Broughton had continued up the river after sunset, 30 October 1792, and did not reach the point where the flag was raised until after moonrise, so that he named Mount Hood for the British Admiral by moonlight, which is not noted in the narrative. Just opposite the point named Point Vancouver a large building has been constructed on the cliff as a Memorial. This is apparently the Vista House, to which reference has been made.

THE VOYAGE OF THE *METEOR*

DIE *METEOR*-FAHRT. Forschungen und Erlebnisse der Deutschen Atlantischen Expedition, 1925–1927. By F. SPIESZ. *Berlin: Dietrich Reimer* 1928. 10×8 *inches;* xvi+376 *pages; illustrations and maps. M.*20 (*brosch.* 18)

THE cruise of the *Meteor* marked the beginning of a new stage in the history of oceanography. Previous expeditions had been either pioneering or else devoted to the study of restricted areas or special problems. The *Meteor* was the first ship to make an intensive study of a whole ocean. Preliminary accounts of the scientific work were published from time to time while it was still in progress, and now we have a more popular and general narrative by her commanding officer, Captain Spiesz. In it he tells of the origin and planning of the expedition, the long delays due to financial difficulties which were overcome only by the help of the Notgemeinschaft der deutschen Wissenschaft, the almost secret fitting out, the trial expedition of nearly a month, the voyage itself and its methods, and finally of the reception accorded to the *Meteor* in foreign ports and by German settlers abroad.

The proposal for an oceanographical expedition originated in 1919 in the Nautical Division of the German Admiralty and was received with enthusiasm by the Naval Command, since at that time it was only in an unarmed surveying ship that it was possible to show the flag abroad and maintain touch with Germans in foreign countries. The ship chosen was the half-completed gunboat *Meteor*, laid down before the War, 164 feet long and with a displacement of 1200 tons, about that of a modern destroyer. The cost of the ship and her crew was borne by the Navy, while the Notgemeinschaft met the extra cost of a long voyage and provided for the scientific staff and apparatus. The first suggestion of Dr. Alfred Merz, the scientific chief of the expedition, was for a three-years' cruise in the Pacific Ocean; but this could not be carried out since the money was not forthcoming to provide the Diesel engines which the long runs would have made necessary. The ship was therefore completed as a coal-burning steamer, and Dr. Merz turned his attention to the Atlantic Ocean. This was probably a gain to oceanography, for a cruise in the Pacific would have been largely pioneering, while enough was known of the Atlantic Ocean to make it possible to draw up a well-considered programme.

Dr. Merz and his pupil and assistant, Dr. Wüst, had re-examined all the observations available from the area and had come to the conclusion that the circulation was not the simple symmetrical twofold system that had been assumed, but rather fourfold. According to their theory there is first an upper warm salt layer; then beneath it the Antarctic Intermediate Current of colder fresher water, which sinks from the surface between 40° and 50° S. lat., and can be traced beyond the equator; beneath this again the Deep Current of warm salt water which originates on the surface of the northern sub-tropics and can be followed to 50° or 60° S. lat.; and under all the Bottom Current of cold water which is formed along the edge of the Antarctic Continent and can be recognized as a distinct body of water at least as far as the equator. Merz's programme was directed to a complete investigation of this circulation in all directions, and of its dependence on the contours of the bottom and on meteorological conditions, and nothing was to be undertaken which interfered in any way with this task.

The first essentials were determinations of the depth, and temperature and salinity from surface to bottom, at a large number of stations at distances of about 150 miles apart on thirteen sections or "profiles" drawn across the Atlantic Ocean south of 10° N. lat. These were for plotting the positions of the various

bodies of water and for calculating their rate of flow by dynamical methods. The calculated velocities were to be checked by direct current measurements made while the ship lay at anchor in deep water, and the general conclusions by determinations of the other chemical properties of the water and by counts of the plankton organisms. Bottom samples were to be collected at every station, and the meteorological conditions in the upper air were to be observed by means of pilot balloons, kites, and smoke shells from an anti-aircraft gun.

This programme was carried out almost in its entirety. The *Meteor* spent 512 days at sea, during which she steamed over 67,000 miles and made 310 oceanographical stations, and also anchored ten times in deep water. The observations which have been published so far show that the theory of the fourfold circulation is correct in its broad outlines, though the differences between the east and west sides of the Central Rise appear to be greater than had been expected. The current measurements made at anchor in deep water must be considered doubtful, since it is very difficult to eliminate the false current due to the yawing of the ship. Better results might have been obtained by allowing the ship to drift past an anchored buoy, the bearing and distance of which were continually determined. The anti-aircraft gun was seldom used for fear of damage to the thermometers.

In January 1925 the *Meteor* started on a trial cruise, the results of which were disconcerting. In particular the speed was lower and the coal consumption greater than had been expected. Some improvement was made by fitting a larger propeller and square-rigging the foremast, but even then she remained a "coal eater," and the programme for the longer runs had to be altered. On April 16 she sailed for Buenos Aires, which was to be the starting-point of the expedition. On passage she carried out meteorological observations and anchored once in deep water, but no other oceanographical work was done. On June 3 she left Buenos Aires for Cape Town on the first profile; this lay in the "Roaring Forties" and was the hardest of all, and, what was worse, the work had hardly begun when it became necessary to return in order to land Dr. Merz, who was suffering from a relapse of an old lung trouble. The work was resumed where it had been dropped, but the programme had to be modified on account of continual bad weather culminating in a hurricane, during which the ship drove close past Gough Island. Before going into harbour Captain Spiesz took his ship into the lee of Robben Island for two days and arrived at Cape Town glistening with fresh paint. The reception which she met with surprised and delighted her crew. The Governor-General and the Countess of Athlone paid visits of inspection, as did members of the Government and German settlers, and excursions were made to various places. During the second profile the news of the death of Dr. Merz was received, and Captain Spiesz took over the post of chief scientist.

The author describes each of the profiles in detail and uses them as opportunities for the interpolation of accounts of the various branches of the work written by the specialists concerned. The results of the echo-soundings are shown in a preliminary chart. Two echo-sounding machines were carried, one made in Germany by the Atlaswerke on the model of the American "Fathometer" and the other made by the Signalgesellschaft of Kiel; their indications generally agreed to 10 or 20 metres in deep water. Soundings were made every 2 or 3 miles —over 33,000 duplicate soundings in an area where previously there had been only about 3000, and those probably of inferior accuracy. The bottom topography proved to be more irregular than had been supposed, especially to the eastward of the Central Rise, and the Rise itself was found to turn eastwards south of Africa as the Atlantic–Indian Connecting Ridge. Other interesting discoveries were the ridge between South Georgia and the South Shetlands,

which closes the Southern Antilles arc, and the South Sandwich Deep of 8060 metres eastward of the group, connecting the deeps of the South Polar and the Argentine Basins. A deep channel was found through the Rio Grande Ridge, and the temperatures give reason to suppose that the Central Rise is cut through in the neighbourhood of the Romanche Deep. Interesting points are that the echo-sounders proved useless for detecting icebergs, and that the echo does not always return from the nearest solid; on one occasion when the *Meteor* was at anchor in the Straits of Magellan the echo was returned from the bottom although the cliff was nearer.

The book is well got up and printed, in Gothic type, has a good index and is extremely well illustrated. In addition to the figures in the text and the charts in the pocket at the end, there are 416 photographs, mostly of small size but nearly all excellent. They illustrate every side of the voyage—apparatus, birds and fishes, coastal views and scenes on shore, and of course the crew and the *Meteor* herself. One of the latter shows the stern with an Iron Cross and the date 1870, a battle honour handed down from an earlier *Meteor*, which in some ports led to unkind remarks as to her age.

Captain Spiesz's book will be read with pleasure and profit by oceanographers, especially those who may have to fit out an expedition, and they will find his German more readable than that to which they have been accustomed in scientific books. One of the most important lessons which they will learn from it is the importance of a large radius of action. *Meteor's* small coal capacity made it necessary to modify some of the programmes and even at times to stop the steam-steering gear and to be economical in the use of the electric light and the echo-sounder. This added greatly to the discomforts which the crew had to bear, and it was under such conditions that Captain Spiesz could congratulate himself on having the backing of picked men and of naval discipline. D. J. M.

THE PLACE-NAMES OF SUSSEX. By A. MAWER and F. M. STENTON, with the assistance of J. E. B. GOVER. Part I, the Rapes of Chichester, Arundel and Bramber. (English Place-name Society, vol. 6.) *Cambridge: University Press* 1929. 9 × 6 *inches;* xlvi + 250 *pages; and map.* 40*s for* 2 *parts*

This, the sixth volume published by the English Place-name Society, deals in characteristically thorough style with the three western Rapes of Sussex, and the Eastern Rapes will form the subject-matter of vol. vii. The present instalment interprets the names found in twenty-one Hundreds in an area roughly defined on the east by a line drawn from north to south from Crawley to Southwick. Under the Rapes the Hundreds are dealt with in geographical order west to east, and the places under the Hundreds alphabetically. The editors acknowledge abundant help given by members of the Sussex Archaeological Society, and a grant received from the British Academy which made possible the collection of material from unpublished documents, "with the result that search of printed and unprinted material has been more extensive in this county than in any as yet attempted by the Survey."

A beginning is made with river-, road-, district- and forest-names. The Celtic element in Sussex place-names is so small as to suggest "the virtual extermination of the local Romano-British population." Even in river names there are very few exceptions to English naming, *e.g.* Tarrant, the old name of the Arun, Lavant, and Limen (in Limden). Anderida seems to be the only Celtic place-name, and of course Pevensey has superseded that. The course of events in the misty beginnings of Sussex to be inferred from the place-names agrees very closely with the annals relating to the conquest, thus to some extent confirming them. Sussex was conquered before the end of the fifth century, and in an expedition independent of the movements which created the kingdoms of Kent and Wessex. In the difficult Weald country one must infer, *e.g.*, that the remnant of the Roman-British iron-miners was completely wiped out by the Saxons, some of whom for long lived in isolation in Wealden swine pastures. The high antiquity of several names helps to disprove the idea that the Weald formed a trackless wilderness in early Saxon times; and indeed this inference of the editors might apply on quite as valid evidence to the Roman era and to the ages before it as far back as Neolithic times. For all practical purposes the "trackless Weald" theory should be discounted. Before the end of the sixth century the south of Sussex had been thoroughly settled in village communities: the -ingas names in great number represent the earliest English settlements. Interesting suggestions derived from names are, first, that holy places of the pagan Saxons were sometimes possessed by individuals, and that the South Saxons lived an isolated and remote existence. But the particular historical importance of Sussex place-names lies in the local vocabulary of the county rather than in the personal names, for the word-list which can be derived from it "is far larger than that given by the names of any other single district yet covered by the Survey": it includes, *e.g.*, woodland words like rispe (briars), writh (thicket), telga (young oak), and sciete (corner of land), slind (slope), hiun, heon (family). The editors are led to believe that, in spite of their apparent unity, the South Saxons may have been an amalgamation of different folks: at the end of the seventh century at least three persons were bearing the royal style in Sussex at the same time, and as late as 1011 the Haestinges of East Sussex were regarded as people separate from the true Sussex people, *i.e.* the men of Aelle and his sons.

Perhaps the most disappointing thing about Sussex place-names is the lateness of the river names. Arun, Chilt, both Rothers, and Stor are all back-formations;

Adur is a poet's invention, and Ouse is probably a mistake for ooze. And they all look so Celtic. Amends, however, are made by the word Rape, unique in England. Its practically certain derivation is from OE. rāp (rope), the reference being to a custom by which the limits of a popular open-air court were defined by stakes and ropes; a "rope" then was a court, and afterwards the area of its jurisdiction (cf. Dutch *reep*). Of interpretation the following may serve as examples: Lurgashall, Lutegar's healh or nook of land; Petworth, Pytta's enclosure; Arundel, hār-hūn dell, hoarhound-valley, the plant being profuse in the neighbourhood; Adversane, hyrne or corner of the Hadfold estate.

The Introduction contains *Addenda et Corrigenda* to vols. i–vi (pt. 1).

S. E. W.

A DETECTIVE IN KENT. By DONALD MAXWELL. *London: John Lane* 1929. 7×5 *inches;* xiv+164 *pages; illustrations and sketch-maps.* 6*s*

Mr. Maxwell provides us with more adventures with a sketch-book. There is a freshness in this work, which is illustrated with fascinating pen-and-ink drawings. He takes us to that interesting country, the marshes bordering the Isle of Thanet, and then to Romney Marsh. Some of the author's difficulties as a detective would have been solved by a study of old maps. Mr. Maxwell "imagines" Reculver was an island. Miss Mothersole quotes a passage from the Sandwich MS. which states that "Severus built the Castle of Reculfe or Reculver in the island of Tindelade;" and the map of Andrews, 1779, shows that the estuary of the Wantsum had three entrances, the two westerly of which unite and surround the ruins. Mr. Maxwell has some difficulty in accepting the view that the name Sarre is connected with the Latin Serra, a saw. He tells us that the old name for Sarre was Ville de Serre; but then he loses his clue. The map by Sam Parker, 1719, shows the crossing of the river at Sarre: it is marked "Sawbridg." Weekley says that the most primitive bridge was probably a wooden causeway over a swamp. This avoids the difficulty of the "serrated coast" margin.

The significance of the names Gore Street and Gore End is further explained by the analogy of Havengore Island. An old chart depicts this island as having a triangular spit or *gore* of sand projecting into Wakering Haven. Some of the finds are particularly interesting, especially the Phantom Shipyard which rejoices in the name Puddle Dock. Space prevents us following the author farther; but his travels and observations are full of suggestive ideas.

H. M. E.

HADRIAN'S WALL. By JESSIE MOTHERSOLE. New and revised edition. *London: John Lane* 1929. 8×5 *inches;* xxx+245 *pages; illustrations and maps.* 5*s*

This is a fourth edition of Miss Mothersole's popular account of Hadrian's Wall. Much has happened on the Wall since the first edition of October 1922, and in her new preface the author briefly states the chief points in which progress has been made: "but fresh discoveries only tend to confirm the conclusion that the forts and Vallum, enlarged forts, and stone Wall were all successively carried out by Hadrian, within a very short space of time." The Wall was originally planned to start from Pons Aelii westward; the narrower extension eastward to the estuary was an after-thought. This new edition of a pleasant companion-guide is very welcome.

S. E. W.

TRAVELS IN FRANCE DURING THE YEARS 1787, 1788 AND 1789. By ARTHUR YOUNG. Edited by CONSTANTIA MAXWELL. *Cambridge: at the University Press* 1929. 8×5 *inches;* lvi+428 *pages; portrait and map.* 12*s* 6*d*

The first edition of 'Travels in France during the Years 1787, 1788 and 1789, Undertaken more particularly with a View to ascertaining the Cultivation, Wealth, Resources, and National Prosperity of the Kingdom of France, by Arthur

Young, Esq., F.R.S.' (to give the book its original title) was published at Bury St. Edmunds in 1792, and may be seen in the R.G.S. Library, where also may be found a reprint in vol. 4 of Pinkerton's Collection of Travels (London, 1809). Young divided his work into two parts, the Journal and the General Observations, regarding the latter as more important, but including his journal on the ground that this form of record carries greater credibility. The result was a document which has always been regarded as of first-rate historical importance. There have been several editions of the "Travels"; but the present claims to be the first since Pinkerton's to reprint any of the General Observations beyond "The Revolution in France." There is an excellent introductory essay of some forty pages; many useful notes are collected at the end, where there is also a careful bibliography of works referred to by the editor. Young's routes shown on the map are such as a present-day owner of a touring car might display with pride.

J. H. R.

THE BLACK FOREST, ITS PEOPLE, HISTORY AND TRADITIONS. By CHRISTOPHER MARLOWE. *London: John Lane* 1929. 7×5 *inches;* xiv+224 *pages; illustrations and sketch-map.* 8*s* 6*d*

The author deals with the Black Forest, with a special eye to its facilities for ski-ing, skating, and tobogganning in ideal surroundings. Since the war a veil has been drawn over this country, and this Mr. Marlowe lifts, while also giving some account (chapter 2) of changes brought about by the war. "The private car still has the forest almost to itself." The book is well written by a sympathetic guide who allows little of interest to escape him and justly appreciates what a visitor wants to know, especially in the way of routes: its attractive pages should help to reopen to the tourist a delightful district of Central Europe.

S. E. W.

GEOGRAPHIE DER SCHWEIZ. By J. FRÜH. Parts I and II. *St. Gallen: Verlag der Fehr'schen Buchhandlung* 1929. 11×7 *inches;* 324 *pages;* 5 *plates and* 85 *illustrations in the text. Fr.* 6 *each part*

These are the first two parts of a comprehensive work on the geography of Switzerland which will extend to about 2000 pages. It is to appear in twelve or fourteen parts, and it is expected that the parts will be issued at intervals of about two months. The work is published by the Union of Swiss Geographical Societies, with the help of a grant from the Swiss Confederation.

Within the last ten or twelve years a number of notable works have been brought out which deal with Switzerland from the point of view of some particular branch of knowledge. Heim's 'Geologie der Schweiz' may be mentioned as an example. These are for the specialist and not for general use. They are pictures of the region, each from its own standpoint; the present author's aim is to combine them into a complete image, less detailed but equally true in all its aspects. In practice this means, in a book, that each aspect is presented in turn, but their relations to one another are kept continually before the mind; and this is plainly the author's intention. How far he will succeed it is yet too early to say, but it is already clear that the work will be one of the best regional geographies in existence. The first two parts are naturally concerned with the physical geography. There is an introductory section of forty-eight pages, which includes, amongst other matters, an interesting historical sketch of early works and maps dealing with the area. Geology and structure occupy sixty-eight pages. Unless the reader already has some knowledge of the subject he will not easily follow the account of the complex tectonics of the Alps; but his task is lightened as far as may be by the inclusion of Heim's section of the Swiss Alps and Staub's tectonic map. Rather more than a hundred pages are allotted to land-sculpture, and this is one of the most generally interesting sections. The Jura has a special section

of about thirty pages. The last sixty pages are devoted to climate, but there is more to follow in the succeeding part.

The prospectus states that the book is neither a text-book nor a picture-book. Aesthetic considerations have had to give way to the great mass of material for which room must be found. But the illustrations are excellent and have been carefully selected for the purpose in view. The plates include a coloured geological map of Switzerland, Heim's section of the Swiss Alps, Staub's tectonic map of the area, a part of the Swiss topographical map (scale 1/50,000) illustrating the character of a glaciated gneissic region, and a beautiful relief map of Switzerland printed in brown.

Switzerland will be fortunate in possessing a work such as this promises to be.

P. L.

JOGGING ROUND MAJORCA. By GORDON WEST. *London: Alston Rivers Ltd.* 1929. 9×6 *inches;* 256 *pages; illustrated by* WARWICK LENDON. 12*s* 6*d*

The title of this book sufficiently expresses its scope and purpose. It is a very entertaining account of a holiday visit to Majorca. The author, accompanied by his wife, has made a comprehensive survey of all the chief places of interest, sometimes by public diligence, sometimes on foot, sometimes on a mule, and he has been quick to note their special characteristics. He has much to say of the habits and customs of the people, and seems to have had the advantage of being able to converse with them in their own tongue. He writes appreciatively of the excellence and cheapness of the more simple *fondas*. There is a good description of the journey across the mountains from Soller to Lluch and Pollensa. One may also explore with the author the caves of Artá: some of the stalactites, he claims, are 100 feet high. As a light work of travel this volume can hardly be surpassed. Mr. Gordon West has caught and admirably expressed the charms of this lovely Mediterranean Island.

A. W. S.

THE ROMAN CAMPAGNA AND ITS TREASURES. By GILBERT BAGNANI. *London: Methuen & Co.* 1929. 8×5 *inches;* xii+320 *pages; illustrations and sketch-maps.* 10*s* 6*d*

Mr. Bagnani has produced a useful guide to the Roman Campagna, which, like many other things in Italy, is rapidly changing its character. But in this case even the artist and the archaeologist can hardly grudge the change, seeing that it is due not a little to the elimination of malaria. This is a book to be used on the spot rather than to be read at home, more especially by the motorist, who alone will probably have the good fortune to be able to explore the remoter corners of this region, which extends up to the frontier of the old kingdom of Naples; and the number of new roads that have come into existence of recent years makes the task much more easy than it was for the cyclist of earlier years. A region so intimately connected with the history of the Eternal City is naturally teeming with interest, and Mr. Bagnani shows himself a competent guide not merely to the county, but to the history and the principal artistic and archaeological treasures of the province he has selected.

L. C.-M.

STONES, HILLTOPS AND THE SEA. By RUTH ALEXANDER. *London: Alston Rivers Ltd.* 1929. 9×6 *inches;* 272 *pages; illustrations.* 12*s* 6*d*

This strangely titled book describes a conducted tour by motor coach in Yugoslavia from Zagreb to the Adriatic near Fiume, then inland through Bosnia and Hercegovina and out again at Dubrovnik (Ragusa), and thereafter along the coast. The contrast between the Slav interior and the "Italianate" seaboard is well brought out. But the Adriatic cities are now pretty well known to tourists; the most noteworthy piece of new information concerns the decay of Zara since

it became an Italian enclave in Yugoslavia. More entertaining are the descriptions of the inland towns and scenery, with amusing accounts of inns and bazaars.

The valiant attempt to give correct Yugoslav spellings has come to grief through an excess of zeal in conferring diacritical marks where none should be, as over the *c* in Hercegovina. A preference for Italian to Yugoslav names hardly justifies the remark that "vowels matter so little in the Slav language that they are frequently dispensed with altogether or change places with agreeable ease"; in any case Rab and Arbe are not an example, as Arbe is Italian. "Zengg" is neither Italian nor Yugoslav, but Magyar.

There is no map nor index. Many of the photographs are too small to be of much value.

J. H. R.

HELLAS REVISITED. By W. MACNEILE DIXON. *London: Edward Arnold* 1929. 9×6 *inches;* xi+209 *pages; illustrations and maps.* 10*s* 6*d*

Professor Macneile Dixon's Preface modestly describes his book as "only the record of a journey, mingled with reflections on the scenes and sites revisited." But there is room, and a welcome, among the mass of books on different aspects of Greece, for this one. If, as he declares, it is not "a piece of scholarship," it is something more appealing to the general reader—the fruit of a scholarly mind which has never lost its freshness and humanity, nor its enthusiasm for Greece as "the fatherland of every thinking soul."

The introductory chapter, and those on the Greek achievement and the history of Greece, prove at once the writer's peculiar aptitude for analyzing racial characteristics, and for making history concrete with a telling phrase. He has an artist's sensitiveness to the Greek genius, with its intellectual power and "spatial sense" expressed in architecture and sculpture; its calm certitude of touch in art and literature—resulting in economy of line and word. The Lion of Chaeronea, marking the burial-place of the Theban dead—

"A Lion where the lion-hearted lie,"

of which a beautiful pencil drawing is reproduced here, seemed to Professor Macneile Dixon and his travelling companions "the most noble and imposing monument . . . that we had ever seen, so simple in conception, so magnificent in pose." But it was not so much the historic battlefield that he desired to see at Chaeronea, as the birthplace of Plutarch, "the friend of the whole world," and the retreat which he chose for his happy old age.

This modern traveller, with his receptive spirit, found Greece still an enchanted land; and his insight gives to the old mythical figures a new vitality and deeper significance. He describes one memorable scene after another in words that convey something of their haunting beauty to the reader. At Hippocrene, for instance, which lies 5000 feet above the sea, "hidden from the world in a dell under the eastern peak of Helicon," he drank pure ice-cold water drawn by the muleteers from a well covered by lingering snow, while the glade below was carpeted with brilliant spring flowers. Northward, he looked down at the Valley of the Muses, and "far, very far off, there gleamed a misty cone, . . . the spear-tip of the giant Olympus. . . . So was crowned a day of holy wonders in the heart of ancient Greece."

The author's charm and wise reflectiveness will satisfy those who already share his devotion to the immortal names and sites; and his book may well prove an incentive and a guide to future travellers in Greece. Mrs. Bryce's graceful pencil drawings are worthy of this admirably produced volume, and of their subjects.

M. K.

ASIA: AN ECONOMIC AND REGIONAL GEOGRAPHY. By L. DUDLEY STAMP. *London: Methuen & Co.* 1929. 9×6 *inches;* xx+616 *pages; diagrams and maps.* 27*s* 6*d*

Professor Dudley Stamp has returned from many years of service in Burma, during part of which he was Professor of Geography and Geology in the University of Rangoon, and from visits to other parts of Asia, with a keen interest in the continent and special knowledge of the south-eastern area. He has prepared a most useful volume on its commercial and regional geography. It should be of special service to British geography students, for it devotes most attention to the Asiatic countries of most concern to them and gives ample reference to the modern literature on the subject in English. It is especially thorough as a guide to the Asiatic contributions in the *Geographical Journal*. The seven introductory chapters deal with the relief, structure, climate, vegetation, and people, and include a note by Miss Fisher on the European exploration of the continent. The larger part of the volume consists of ten chapters on the main political divisions of Asia; each describes briefly the physical features, with usually a paragraph on the geology, and deals at greater length with the climate, vegetation, population, communications, products, and trade. The account of the structural geography is brief and does not overlap with 'The Structure of Asia' recently issued by the same firm. The author quotes the conclusions of Kropotkin's paper on the Orography of Asia, and retains Suess' view of the marginal arcs of Eastern Asia, both of which are now superseded. The reference to Kropotkin would make a reader overestimate his personal contributions to Asiatic exploration. Kropotkin is indeed one of five names mentioned as the most extensive explorers of Central Asia. He is the only Russian in the list. The most serious defect in the volume is the scanty reference to Russian geographers and geographical work. This omission is probably due to the inaccessibility of much of the Russian literature to British readers. Consideration of the readers' needs has determined the allotment of space; the section on India and Ceylon amounts to 206 pages, as against 30 pages for Russian Asia, 71 for China, and 9 for Indo-China.

Amongst other new suggestions the author introduces from Australia the term "the Dead Heart of Asia" for the central deserts, and from Canada the term "shield" for the ancient nucleus of North Central Asia. A shield is a covering structure and not a central core, and though the term was suitable from its shape to the part of Canada to which it was applied, the unit in Asia would be more aptly compared to a boomerang.

The chapter on Asia Minor is especially instructive from the impressions formed during the author's journey there in 1928; it pays high tribute to the remarkable achievements of Kemal Pasha in the re-establishment of Asiatic Turkey. The population of Arabia is given on page 45 as 5,000,000; but the figures for the subdivisions on page 134 add up to 7,000,000, which is the usual estimate. Some modern authorities regard the figures generally accepted for the population of China as greatly exaggerated. The amount given by the Chinese Postal Census of over 485,000,000—exclusive of Tibet and Mongolia—may be too great, but the author considers that the number is over 400,000,000. The discussion of the over-population of China perhaps attaches inadequate importance to the under-population of large areas owing to the defective nature of internal communications and means of transport. Miss Fisher, in the outline of Chinese History (p. 474), remarks that the Chinese may have had their origin in "the cradle of civilization—the land of Sumer"; she gives the date of Yeo the Great, founder of the Feudal Period in China, as B.C. 2357. The pre-Feudal period was probably far too long to be included between then and the time of the Sumerians.

The author, in dealing with the relations of the eastern and western parts of the East Indian Archipelago, gives the alternative explanations of Brouwer, who regards the main tectonic line as bent back in a hair-pin bend around the Banda Sea, and of the reviewer who regards the lines as continuing eastward across Papua.

The volume is illustrated by over 300 excellent sketch-maps and diagrams; they relate mainly to the commercial geography and use the statistics for the last year available. J. W. G.

CRUSADER'S COAST. By EDWARD THOMPSON. Illustrated by C. E. HUGHES. *London: Ernest Benn* 1929. 9×6 *inches;* xii+192 *pages; and illustrations.* 10*s* 6*d*

There have been numerous little volumes written by combatants during the war in Palestine. The land seems to inspire people to authorship. Some deal with military occurrences, some mainly with geography, history, or archaeology, but we have seen no volume which so successfully conveys the charm of Palestine. No book, save a professed Flora, has so much about the flowers and trees, and of these the writer never wearies of writing with enthusiasm. Those who know Palestine in the glory of spring will welcome such a book. The chapters are reprints of articles published at various times in periodicals, and consequently there is some lack of system and cohesion. Some are "War Memories," and others—perhaps the most interesting—are grouped under "Syria in 1927." There is an interesting chapter on the much-debated "Palestine Crocodile," and another on the still only partially explored Dog River Caves. The pleasant literary style makes it all delightful reading, and the charming sketches by C. E. Hughes add greatly to the value of the book. E. W. G. M.

TRAILING THE GIANT PANDA. By THEODORE and KERMIT ROOSEVELT. *New York and London: Charles Scribner's* 1929. 9×6 *inches;* x+278 *pages. Illustrations and map.* 16*s*

This story is a racy account of a remarkable achievement. The object of the expedition is kept in view the whole time, and the climax is reached at the right moment, the story then ending on a top note. It is written for people who have never been at any rate in China, nor will the average Asiatic traveller learn anything new from it. But in saying this we are forgetting that this book was written red-hot from the trail, for people who wanted action and adventure, not philosophy or scientific results. This public is not supposed to be acquainted with the works of Gill, Rockhill, Pratt, Cooper, or Prince Henry of Orleans; nor does the work pretend to compete with such standard works—it is what Bacon calls a book for the day.

The expedition returning home reached Yunnanfu early in May, and the United States presumably a month later; the book was published in New York in October! This is to be explained by the fact that the brothers wrote alternate chapters in the field as they went along. In the circumstances there was no opportunity to verify anything, and some mistakes and several rather reckless statements are allowed to get past in consequence. Nor was there even time to embody the results of calmer reflection or research at home.

On the other hand, because the Roosevelts and their companion did what no other white man has succeeded in doing—though many have tried—it will long stand not only as a record of great achievement, but also to some extent as a work of reference. Of course there are the usual mistakes inevitable in a book written on the spot: the "Cactus" hedges of Yunnan, for instance, are really Euphorbia hedges; the Beeches referred to on pp. 172 and 176 must be either Hornbeam or

Castanopsis; there are no true beeches in Western China. The transliteration of Chinese place-names follows no recognized standard, and being inconsistent, is no doubt phonetic; but *gnu* for *niu*, the Chinese for cow, is more than a faulty transliteration. Less permissible are half-remembered names, such as "Crossoptilus Tibetenus" for *Crossoptilum tibetanum;* and it is surprising to find such experienced explorers repeating the old travellers' yarn about the "highest mountain in the world" close to Tachienlu; nor is that mountain more "mysterious" than a hundred others in Western China. When we come to the Giant Panda itself, we find on p. 183: " Personally I am sure the panda is not a bear. It does not hibernate in Muping, whereas the black bear does." The zoologist will want more than an *ex cathedra* statement based on no other evidence than that *Aeluropus melanoleucus* does not hibernate, to convince him that he has long laboured under a delusion. The Sloth Bear of India (*Melursus ursinus*) is a " bear," but it does not hibernate. The best evidence whether an animal is a bear or not is furnished by the skull; and zoologists agreed long ago that *Aeluropus*, though singular, was in relevant features much more bear than anything else. The structure of the tympanic bulla and the dentition are clear on that point. The only alternative would be to raise a new genus into a new family!

The points raised above concern only the student, who may think that the zoological notes on the panda itself might have been fuller and less open to question. The less exacting reader will find in 'Trailing the Giant Panda' a good yarn of bold adventure, well organized, well carried out in the face of difficulties, and crowned with a thoroughly deserved success. The photographs are interesting and the pictorial map cleverly adequate.

THE ASSYRIANS AND THEIR NEIGHBOURS. By the Rev. W. A. WIGRAM. *London: G. Bell & Sons* 1929. 9×6 *inches;* xvi+247 *pages; illustrations and map.* 15*s*

This book is the result not only of Dr. Wigram's long study of Assyrian ethnology and history, but of his recent visit to that part of the ancient people now resident in the kingdom of 'Iraq. He is an authority on this subject who makes his learning accessible to the plain man, and of peculiar interest to those who, during the war or since, have been in contact with a race which has shown itself capable of heroism and loyalty.

Dr. Wigram begins with a chapter on "National Stocks in Mesopotamia," tracing the origins of the Assyrians back to the early days of Ur and "the rise of that upstart and parvenu city, Babylon"; pointing out that "up to the dawn of the twentieth century the village life was still that of four thousand years ago." In that continuity of existence lies the fascination of the land for the observant and, above all, for the archaeologist at the present time.

It was "Assur," or Assyrian emigrants, who moved northward and founded the cities of Calah (of which the ruins now bear the later name of Nimrud) and Nineveh. In that period of national vigour and prosperity they became the first military power in history; and their battering-rams and catapults furnished "the world's artillery" for some two thousand years. But after the fall of the empire, Assyrian history is a long record of invasion, conquest and re-conquest by Eastern and Western nations—Persian, Greek, Roman, Mongolian, Ottoman, with Arabs continually drifting in from the desert to establish themselves in the fertile lands watered by the rivers. Finally, in the seventh century A.D., the Arabs came, not as casual immigrants, but as the united, overwhelming force of militant Islam. The new Moslem rulers, however, gave the Assyrians, who were Christian from primitive times, the status of a "millet" in the country they had wrested from Persia, with a measure of tolerance and protection—though persecution

and massacre for their faith could never be remote contingencies under the Khalifs' government.

Side by side with the hardy Assyrians' struggle for survival under successive tyrannies, there has been the clash of racial and religious feuds, carried on with Oriental fanaticism. Edmund Candler described the Turk in Mesopotamia as "the greatest sterilizing agent the world has known"; and deliverance from that yoke has left these neighbouring peoples with all the elements for strife among themselves in diversity of tribe, creed, and practice.

Dr. Wigram has published an earlier book on the Monophysites, and he must be one of the very few Englishmen who could distinguish the differences of the ten Christian Churches, each represented by a bishop or patriarch, in the city of Mosul to-day. He writes in no partisan spirit, and carries his scholarship so lightly that this book is likely to be (for laymen and ecclesiastics alike) a permanent mine of information, as well as a very readable history of the Assyrians, past and present. M. K.

FOUR MONTHS' CAMPING IN THE HIMALAYAS. By W. G. N. VAN DER SLEEN. Translated by M. W. HOPER. *London: Philip Allan & Co.* 1929. 10×7 *inches;* xiv+212 *pages; and illustrations.* 21*s*

During the course of what had been an extended tour for scientific purposes, chiefly geological, Dr. Sleen paid two short visits to the Himalaya, and has written a very pleasant account of his journeys in the Sutlej Valley and also in the neighbouring hill country lying between Rampur and the Kulu border, probably nearly all in Seorai. The book is pleasant, chiefly because it is written with such evident enjoyment, but the author, perhaps excusably, as he was travelling in a country to him entirely new, rather considers himself as an explorer, whereas every inch of the country over which he travelled is extremely well known. That does not, however, detract from the charm of the narrative.

It is evident from the start that Dr. Sleen is a man of considerable good nature and also, we may say, rather lucky. His interviews at Simla with candidates for his service clearly show this, and his luck in getting trustworthy English-speaking hill servants so very rapidly and apparently without outside assistance was really very great indeed.

His route took him along the great Tibet–Hindustan road, and from this he occasionally made diversions either in search of game or to follow up his geological and other observations. Starting in June, he travelled up the Sutlej Valley to Chini and to Pangi and Jangi, a short march beyond. His numerous excursions on the hillside, however, require a few remarks. From the high points that he reached he describes the surrounding country. Evidently he has had little training in mountain travel, for his descriptions contain many inaccurate statements. There is no thick vegetation anywhere at 18,000 feet, nor are the ridges which he ascended surrounded by several mountains of over 26,000 feet in the immediate neighbourhood: that is a ludicrous statement. The two highest mountains anywhere within reach of such ridges are the Shilla peak of 23,050 feet, and Leo Pargial (not Pir Panjal, as he calls it) is only 22,210 feet, and not 28,100 feet. Where Dr. Sleen got this information from we cannot tell, but as he states that these mountains are some 7000 feet higher than the highest part he got to, we may probably reduce his estimates of the heights which he reached by at least 5000 feet. And Chini is but 9000 feet, and not 11,000 feet. On two occasions also Dr. Sleen, as we all do, draws comparisons between the Himalaya and the Alps; but Mont Blanc is not 18,000 feet above the sea, nor is Nanda Devi a mere 23,000 feet. This little error seems to be the only under-statement of altitude in the whole book.

Dr. Sleen passes on his journey by the missionary settlement of Kotghar, which he states is the most northern missionary station, but surely he must have heard of the Moravian settlement of Poo, much farther up the Sutlej than any point he reached, and which has been in existence since 1865, though since the War it may not be in full operation.

There are a good many other inaccuracies in the book. The Ganges, for instance, does not rise near Man Lakes, nor can the Pir Panjal or the Badrinath Peaks be seen on the same clear day. Dr. Sleen appears to mix Leo Pargial continually with the Pir Panjal, which he should have known is the ridge of mountains dividing Kashmir from Jammu, and whose highest point is under 16,000 feet; and Badrinath is but a temple on the Alaknanda. He probably meant to say the Kedarnath Peaks above Gangotri, the true source of the Ganges. A dictionary would have prevented him from falling into one other small error. The common brown monkey is described as a baboon, and our very athletic friend the langur becomes an ape.

Dr. Sleen is interested by the extraordinary relations between the local gods, which are certainly remarkable, for gods do not only greet each other but practically own land, and litigation between them, especially in Kulu, is by no means unknown. Hinduism, as usual, has swallowed whole the original animistic worship of the country and reproduced these individuals, certainly the males, as expressions of Mahadeo.

The book is beautifully illustrated and, notwithstanding the inaccuracies above mentioned, is very readable; but there is no map. We are informed that Dr. Sleen's scientific observations, not only in the Himalaya but in other parts of India, will follow in a separate volume.

DELHI: ITS STORY AND BUILDINGS. By Sir HENRY SHARP, C.S.I., C.I.E. 2nd edition. *Oxford: University Press* 1928. 7 × 5 *inches;* vii + 137 *pages;* 27 *illustrations and a map.* 4*s* 6*d*

The monuments of historical and architectural interest in and around Delhi are scattered over so wide an area, from the Ridge on the north to Mahrauli and Tughlakabad on the south, that a stranger needs guidance in selecting what sites to see and in what order to see them. Ordinary visitors who have three or four days at their disposal will find in Sir Henry Sharp's scholarly little book a brief but accurate description of the principal monuments in their proper historical setting, bringing the story down to the present day, and so including a short account of the "eighth city," or New Delhi at Raisina. Even the more serious student will find it a useful foundation for further detailed investigation. Possibly the average sight-seer will find too many references to points of purely architectural interest. For those who want more information, besides the publications of the Archaeological Department and Fergusson's great work on 'Eastern Architecture,' there are several books available, pre-eminent among which is H. C. Fanshawe's 'Delhi Past and Present,' which brings its readers into closer personal touch with the characters and memories of the past.

The illustrations have been suitably selected; but the map at the end is scarcely adequate: for example, it does not show the site of the enormous new Parliament Building, or of John Nicholson's tomb—which most visitors like to see. The book is of handy size and well printed. We notice that on p. 46 (l. 14) Nimza should read Nizam; and on p. 89 (l. 5) 1912 should read 1911. C. E. A. W. O.

BEGINNINGS OF VIJAYANAGAR HISTORY. By Fr. H. Heras, s.j. (Studies in Indian History, No. 4.) *Bombay: Indian Historical Research Institute* 1929. 8×6 *inches;* 144 *pages*

It was the late Mr. Robert Sewell of the Madras Civil Service who, some thirty years ago, in the work entitled 'A Forgotten Empire,' first unveiled to present-day European scholars the extent and splendour of the Vijayanagara empire, which dominated southern India in the fourteenth to sixteenth centuries. The capital city, Vijayanagara, now represented by the ruins at Hampi in the Bellary district by the side of the Tungabhadra river, were visited and described by Nicolo de' Conti and Abdu'r-razzak in the fifteenth, and by Paes and Nuniz in the sixteenth, century. Father Heras, whose work as Director of the Indian Historical Research Institute at Bombay is bearing such valuable fruit, has already in the first volume of 'The Aravidu Dynasty of Vijayanagara' (1927), by the study of much additional MS. material and a great mass of epigraphical records since brought to light, vastly amplified and in many respects corrected the story compiled by Sewell, and carried it down to the seventeenth century. In the little volume before us, revealing profound study and much acumen, the author now investigates the hitherto obscure origins of the dynasty that founded this empire, and throws important light upon several periods of its initial history. Father Heras has made a further valuable contribution towards the elucidation of an important yet difficult period of Indian history. C. E. A. W. O.

ROMANTIC CEYLON: its History, Legend and Story. By R. H. Bassett. *London: Cecil Palmer* 1929. 9×6 *inches;* 254 *pages; illustrations and sketch-map.* 7*s* 6*d*

The author states that his book is written "for the supreme joy and emotion of its readers." Although the result falls short of the intention he certainly proves that Ceylon is "a vast storehouse for legend and folklore" from which a great deal of interest and amusement can be obtained. The volume is a collection of fables and fragments, old and new. It is not easy to write a book of this sort for two reasons. The author who is not wise enough tends to be erratic, while one who is too wise is frequently irksome. On the whole Mr. Bassett has steered a happy course between the two extremes. Both "The Pundit's Tale" and "Sabaragamuwa" are good stories and pleasantly written. But the best chapter in the book is on the Pilgrimage to Adam's Peak—so good, in fact, that the author appears to better advantage at descriptive writing than at legend and folklore. There are some twenty drawings which are not unattractive, though we should have preferred the feminine features to have been delineated as Sinhalese rather than European. H. P. W.

CHINA: the Land and the People. A Human Geography. By L. H. Dudley Buxton, with a chapter on the Climate by W. G. Kendrew. *Oxford: Clarendon Press* 1929. 9×6 *inches;* xiv+334 *pages; illustrations, diagrams and maps.* 15*s*

A comprehensive modern geography of China in English has long been a desideratum, for not only has the science made great strides since Little wrote 'The Far East' and Père Richard his 'Chinese Empire,' but much research has also been carried out by investigators, Chinese and foreign, in varied fields. In this well-produced and appropriately illustrated volume the author has incorporated many of the results of this recent work in a framework essentially of his own construction. Mr. Buxton spent some months travelling in China, and here and there introduces fragments of his own experiences, and he has written a book which will evoke much discussion from geographers. He views the country as an anthropologist: after a general introduction, he deals with the people, their

culture and their activities. Whilst recognizing the importance of the geographical factors in moulding the human geography, he reserves the detailed discussion of the topography and structure of the country to his last two chapters, whilst the final chapter, by Mr. Kendrew, deals with the climate.

With his different view-point Mr. Buxton does not hesitate to discard views with which he is not personally in agreement. One cannot help regretting in this connection that Professor Roxby's scheme of natural divisions has been discarded in favour of the author's own, which the reviewer finds very difficult, in the absence of a map, to follow. His fundamental division of China proper is into three—the Northern Uplands, the Central or Great Plain, and the Southern Uplands. The Great Plain is defined as a triangle, with an apex to the north of Peking and a base formed by the Yangtze Kiang from Shanghai to Ichang—a region which does not seem to be a unit on structural, topographical, hydrographical, climatic, historical, ethnographical, or economic grounds, and which is surely not the accepted definition of the Great Plain. If one may be allowed to point out blemishes in a work which is of very real value, it is that Mr. Buxton is hampered by an obscure style and his constructions often puzzle the reader, as on p. 81, "Where sweet potatoes are grown the pigs are allowed in the autumn to grub amongst the relics of the crop, the one concession of substituting animal for human food, but in this case the matter is tempered by the knowledge that pigs fatten readily on these vegetables."

The author is perhaps weakest when dealing with structure, and some of his assertions are open to question—"the immature nature of its (the Yangtze) valley is shown by the fact that there are unsilted lagoons along its course" (p. 14); "every river . . . eats back into its own watershed" (p. 15); "The northern borderland consists of a series of lofty mountains which retain much of their original form" (p. 15).

Many of the maps illustrating the volume are excellent, but in the four index maps one doubts whether the style adopted is a successful blend of the mediaeval and the modern; and in map 1 the graticule is skew to the border. Here and there one finds slips which may puzzle the student, such as the description of the river map on p. 157 as a map of "waterways," and the statement under Agriculture on p. 65 that "Maps will be found in the *Review of Economic Geography*."

L. D. S.

EGYPT IN SILHOUETTE. By TROWBRIDGE HALL. *New York: The Macmillan Company* 1928. 8×54 *inches; 278 pages; and illustrations.* 15*s*

These very varied sketches of Egypt—religious, historical, social and often very fanciful—will appeal to some, while they repel others, by their entire want of arrangement. It is a volume to be dipped into at any lazy moment, preferably in or en route to Egypt. The many anecdotes are well told. Modern politics when they obtrude, are treated from an anti-British standpoint. There are translations of samples of Egyptian literature, but they do not count for much in a foreign tongue. The illustrations decidedly add to the interest of the book.

E. W. G. M.

THE FORTUNATE ISLANDS: Being Adventures with the Negro in the Bahamas. By AMELIA DEFRIES. *London: Cecil Palmer* 1929. 9×5 *inches;* xxiii +160 *pages; illustrations, music, and map.* 7*s* 6*d*

It is certainly true, as the writer remarks, that "to most English people the Bahamas is a Forgotten Colony." The natural position of these coral-built islands, within easy distance of the American coast, makes them far better known on the other side of the Atlantic. If this interesting, though slight, volume can

help toward knowledge of one of the oldest, though not *the* oldest, of the British Colonies, it will not have been written in vain. Miss Defries covers a wide range of subject. She has something to say of the discovery of the Bahamas, and tries to identify them with the Elysium of Homer. She writes vividly about their natural beauty in terms recalling memories of the South Sea Islands. We are shown close glimpses of native life, and chapters are devoted to the Medicine Woman and to the unique Christmas Masquerade, a ceremony not unlike the Mardi Gras. The serenity of the Negroes in danger is often touched upon, and we are made to listen to their rhythmic songs and dances. Probably the section entitled "Ships," in which the writer visits the sponging-grounds and several of the out-islands at considerable discomfort, is the most interesting. She notes that the Berry Islands alone can boast of hills, and that the Biminis are famed for shipbuilding and "rum-running."

The book is enriched with some remarkably clear photographs and a useful map, and has the assistance of a Foreword by "Trader" Horn and a Preface by Rosita Forbes. A. W. S.

AUSTRALIAN DISCOVERY. Vol. I, By Sea; vol. II, By Land. Edited with an Introduction by ERNEST SCOTT, Professor of History in the University of Melbourne. *London: Dent* 1929. 9×6 *inches; vol. I,* xxxvi+412*; vol. II,* xxxii+422 *pages; illustrations and maps.* 10*s* 6*d each volume*

Volumes put forward under the auspices of so well known and so painstaking a historian as Professor Scott of Melbourne have a reputation to sustain, but those under notice perform their task too spasmodically. The wording of their title-pages implies that Professor Scott is responsible for both the Introductions and the editing, which presumably includes the selection of extracts. The notion of retelling the history of Australian discovery and exploration as far as possible in the words of the actual discoverers and explorers, most of whose journals and records are not easily accessible to the general reader, is an excellent one; excellent, too, are the Introductions, which sum up crisply and on the whole with great accuracy not only the progress of discovery but the motives or accidents which originated it and its astonishing results. On the other hand, the selection and editing of the extracts cannot be so praised; frequently one suspects another and a less experienced hand, and occasionally the editorial notes prefixed to the extracts flatly contradict the surely more authoritative Introductions. The author of these notes, for instance, still believes in the long-since exploded myth of the discovery of the Torres letter at Manila; because he chooses to reprint Major's translation of Thévenot's translation of Pelsart's shipwreck narrative, he assumes that the narrative "originally appeared" in Thévenot's book; he makes no attempt to correct such mistranslations of non-British explorers' work as those which make Torres's account of his passage through Torres Straits quite unintelligible; he prints twenty-eight pages of "Allan Cunningham's Explorations," fourteen of which are devoted entirely to those of Captain Sturt, which are later in the book given in full; he represents the work of Thomas Mitchell, the most assiduous and versatile of Australian explorers, by a single extract, taken from his travels in what is now Victoria, and does not reproduce that accurately.

These notes on the inadequacy of what might be called the sub-editorial work in Professor Scott's volumes—and they are merely a selection from the criticisms that the work challenges—serve to show how gravely the volumes need revision before they can be of use to readers in search of accurate information. Serious research students will be well advised to consult the journals from which Scott's extracts are taken. But for the less ambitious inquirer into the conditions of early Australian settlement or early Pacific exploration, who is interested not so

much in the sequence of events as in the nature of the obstacles overcome and the psychology of European adventurers confronted with startlingly strange environments, these volumes supply in a handy form invaluable material. It will be excellent practice for such readers to note the effects produced by Australian coastal conditions on men so diverse in nature as Dampier, Cook, and Flinders, or by the problems of the Australian bush on, for example, Mitchell, Sturt, and Eyre. The second volume is made more valuable by the reproduction of maps, some of them the explorers' own, illustrating the journeys narrated. It would improve the first volume to substitute more maps of this class for the reproductions of earlier geographers' fantastic notions; Ptolemy's ideas can scarcely be considered illustrative of Dampier's voyaging, or Desceliers' of Cook's. Still, with careful revision and a nearer approach to uniformity of quality, the work must prove very useful within its limitations. A. J.

BIRDS AND GREEN PLACES: A Book of Australian Nature Gossip. By ALEC H. CHISHOLM. *London and Toronto: J. M. Dent & Sons Ltd.* 1929. 9×6 *inches; 224 pages; 75 illustrations from photographs and 2 in colour; sketch-map.* 15*s*

The author of this book writes with expert knowledge of the birds which he so obviously loves. He introduces many old favourites—Emus, Bell-birds, Bower-birds, Cuckoo-shrikes, Cockatoos of several species, Parrots of brilliant hues, rare Scrub-wrens, and many others. His discovery in the granite belt of Queensland of a fourth species of Lyre-bird, named *Menura edwardi* in honour of the present Prince of Wales, is vividly described. Writing of the Bower-birds he gives a good description of their remarkable playgrounds, discussing the problems presented from an original viewpoint. The account of Queensland's bird fauna is pleasantly interspersed with descriptions of the country; that of the granite belt is of more than usual interest. His account of the Swiftlets' breeding-cave on Dunk island is particularly pleasing. When discussing the association of certain birds with certain trees—the fondness of the Red Fantail (*Rhipidura rufifrons*) for the tree-fern and the Pale-yellow Robin (*Eopsaltria capito*) for the lawyer-vine—he opens up an interesting subject; analogous cases are known to the reviewer from West Africa, notably the association of the Speckled Pigeon (*Columba guinea*) with the Giginya palm (*Borassus flabellifer*).

Mr. Chisholm paints a depressing picture of diminishing bird-life in Queensland, and we hope that some of the seed which he has scattered may fall on fallow ground. To read that the Bustard is "cruelly persecuted by man" (p. 50) despite the undoubted good it does, that Lyre-birds, Dragoon-birds and Regent-birds are slaughtered "for the sake of their beautiful feathers" (p. 26), that the Nutmeg Pigeon is having its ranks sadly thinned by gunners who fire at massed flocks "for pleasure" (p. 82)—are statements that we commend to the attention of the Society for the Preservation of the Fauna of the Empire. The author may be assured that anything he can do to protect the diminishing avifauna of Queensland will have the heartiest support of naturalists in the old country.

The book is to be commended to all who are interested in Australian bird-life. Many of the photographs are excellent, and it is furnished with a good index; but a better map would have been welcome. D. A. B.

ON THE STREAM OF TRAVEL. By JAMES NORMAN HALL. *London: Chapman & Hall* 1929. 9×6 *inches;* vi+250 *pages.* 15*s*

Mr. Hall's 'Stream of travel' is placid, and no turbulent mountain torrent, but nevertheless delightful. He has not only travelled widely and off the usual tracks, but he has a gift for describing his journeyings and the people he has met. He

carries his readers from the South Seas to Iceland, from Iceland to the United States, and then back to his beloved Pacific Islands. The reviewer's knowledge of Iceland is confined to glimpses of its uninviting-looking coast from a ship's deck; but having a close acquaintance with the Pacific and knowing many of the schooners and characters Mr. Hall describes, he can bear witness to the truth to life of the pictures of the latter region, and has no doubt that those of the former are equally to be trusted. The descriptions of voyages in many of the island schooners where days were spent in looking out for some atoll which the native captain was trying to find—by instinct it is to be supposed—are very typical of present-day conditions.

Considering the absence of illustrations, the price can only be thought high, and it is a pity that the book has not had the benefit of some of the beautiful photographs, both of Iceland and the Pacific Islands, which the reviewer knows Mr. Hall to possess. J. R. G.

FERDINAND MAGELLAN. By E. F. Benson. (The Golden Hind Series.) *London: John Lane* 1929. 9×6 *inches;* xiv+262 *pages; portrait and two maps.* 12*s* 6*d*

The aim of the Golden Hind Series is defined as being to present lives of the great explorers in a form suitable for the general reader. The volumes already published have dealt with the careers of English seamen only, and it is appropriate that the first exception to this should be made in favour of Ferdinand Magellan. Quite apart from the significance of his achievement, with its practical demonstration that the circumnavigation of the globe was indeed something more than a mere theoretical possibility, he was in a very real sense the precursor of the greatest of the Elizabethan navigators; the voyage of the *Golden Hind* may with some justice be regarded as a direct result of the earlier voyage of the *Vitoria*, which can but have supplied both encouragement and inspiration to Drake. Upon altogether different grounds, also, the life of Magellan is well worthy of study. It is not every explorer who has had his Pigafetta; as Mr. Benson points out, it is probable enough that Fletcher's narrative would have been less full of colour if he had not had the Italian as his model. Magellan, moreover, as far as his personality emerges from the materials available—unsatisfactory enough since his chronicler was more interested in the wonders of the deep than in his commander—appears as a figure at once something heroic and something pathetic. It demanded courage of no common order to remain voluntarily in the Laccadives, sharing the lot of his men instead of availing himself of the officer's privilege to escape. Courage was needed also when he was called upon to deal with his half-mad partner, Ruiz Falheiro, but it was most of all required on the great voyage itself. Magellan had to face more than the inevitable dangers of the sea; he was surrounded by traitors, and Mr. Benson, with admirable skill, depicts him as he waited and watched, striking only once, and then suddenly and effectively, until the climax was reached at San Julian. His figure is pathetic also. His honourable service was disregarded by his king, and he was forced to choose between a life of inglorious inactivity and a line of conduct which might earn for him the reputation of being a traitor to his native land. At the end of it all, the height of pathos is reached with his death in an obscure island, cheated of the rich recompense that he had hoped to gain, cheated also of that dearer reward, the honour of having been the first man to complete the circuit of the globe.

To a career full of incident and colour Mr. Benson has, it is perhaps hardly necessary to say, done full justice. He has produced a volume which supplies a fair and accurate account of the life of Magellan and which should serve to make

that life better known to English readers. A few slips, such as the statement that Columbus "made four voyages to Central America" (p. 36), do not really detract from the merit of the book. C. J.

DE EERSTE SCHIPVAART DER NEDERLANDERS NAAR OOST-INDIË ONDER CORNELIS DE HOUTMAN, 1595–1597. Vols. ii and iii. Edited by G. P. ROUFFAER and J. W. IJZERMAN. Vols. xxv and xxxii of the Linschoten Vereeniging publications. *The Hague: Martinus Nijhoff* 1925 and 1929. 10×7 *inches;* lxxxviii+426 *and* lxxvi+440 *pages; illustrations and maps*

The subject of the first voyage of the Dutch to the East Indies—a journey which laid the corner-stone of their present empire—is worthy of an enduring monument, and certainly the foundations of such a monument could not have been more well and truly laid than they have been in the present bulky volumes. Out of the numerous journals and accounts—printed and unpublished—of this expedition which are still extant, the Editors wisely commenced with the publication of the most complete and informing 'D'Eerste Boeck' of Willem Lodewycx, published at Amsterdam by Cornelis Claesz in April 1598, which appeared in this same series in 1915. That same year work was commenced on the second volume, and this saw light ten years later in 1925.

In an exhaustive (and truth to tell rather exhausting) introduction of some seventy pages the Editors thoroughly review the bibliographical and geographical particulars of the accounts reproduced. The chief of these are (i) the 'Verhael,' published in 1597 at Middelburgh by Barent Langenes, which forms the oldest printed version, and of which two editions were published in the same year; (ii) a curious English patchwork "pirated" translation, 'Description of a voyage made by certaine ships of Holland into the East Indies,' etc., published by John Wolfe in London early in the following year; (iii) a *Journal* published by the same Zeeland publisher of (i) in 1598; (iv) an *Appendix* to this version issued by the same publisher in the same year; (v) the exceedingly rare English translation by W. Phillip under the title of 'An Addition to the Sea Iovrnal or Nauigation of the Hollanders into Iaua,' issued by Wolfe in that same year; (vi) another addition to 'd'Eerste Boeck' previously issued in 1598; and finally (vii) a translation of the MS. *Cort Verhael* of Franck van der Does, now in the archives of the Hague.

It is impossible in a brief space adequately to summarize the conclusions drawn by the Editors as to who was responsible for the various accounts, and their grounds for forming them; we can only note in passing that all are exceedingly scarce and one at least (our no. vi) unique. English readers will probably be most interested in the enterprising (if piratical) production by Wolfe of W. Phillip's rather sloppy translations. These are dealt with at length on pp. xxxvii–xli and l–liv. Of the *Addition* only one example (at least up till 1925) is known—that in the Netherlands Historical Maritime Museum at Amsterdam. It is interesting to note that the sole copy hitherto known of a second edition of the 'Verhael' of December 1597 is in the possession of the Mitchell Library at Sydney.

In addition to the detailed description and elucidation of the various Dutch texts, the Editors also give us two most informative essays on a MS. Portuguese atlas of 1590 by Bartholomeu Laço. This atlas, as also the unique "chapter" of Lodewycksz's "d'Eerste Boeck,' forms part of the rich collection of Mr. W. A. Engelbrecht of Rotterdam, who courteously allowed full use to be made of them for reproduction. Although, so far as the reviewer can see, this Atlas of Laço's (only discovered in Spain in 1915) has little or nothing to do with Houtman's voyage, it forms a peg on which the Editors hang a very instructive discourse on geographical discovery and research in the sixteenth

century (pp. lvii–lxxi and 387–416), with particular reference to the discovery of Madagascar, and to the line of demarcation between the Spanish and Portuguese possessions in the Philippines and Moluccas. They also bring forward many new points of biographical as well as of bibliographical and geographical interest, and no student of Iberian cosmography can afford to miss this part of the work, although he may not agree with all of their conclusions. Six of the plates are reproduced from this Atlas.

It may seem presumptuous to offer any criticism of so thorough and monumental an example of research, but it must frankly be admitted that the erudition is at times rather suffocating. To the ordinary reader the work would not appeal (nor, of course, is it intended to appeal) at all. But even the student of this phase of discovery will at times feel overcome by the great mass of learning presented, and some of the annotation is overdone. For instance, on pp. 338–9 we have 6 lines of text as compared with 100 lines of (small type) notes—nor is this exceptional. The genealogical and biographical details are also rather too probing. For instance, why on p. 199 give us a long note on the burgomaster of Middelburgh, Ten Haeff, with six variations of the spelling of his name, and the particulars of his father-in-law?

The third and equally bulky volume appeared early last year. It contains, besides some hitherto unsuspected printed accounts in later works (among them one extracted from Grotius), four MS. *Journals* of various men who participated in the voyage, thus amplifying and rounding off the accounts previously published. In a scholarly Introduction of some 50 pages these fresh sources are discussed and analyzed, as in the previous volumes, although the annotation has here been kept within bounds, and consequently both the Introduction and text of the book are much easier to read. This is not to say that the text is allowed to pass without comment. In this connection the notes of Kolonel S. P. L'Honoré Naber are particularly valuable in elucidating many of the obscure nautical, mathematical, and geographical expressions of that time.

In a well-written preface Dr. J. W. Ijzerman pays a graceful tribute to the work of his late collaborator, Dr. G. P. Rouffaer, to whom the making of this book was literally his life's work. A perusal of this present volume will convince the reader that the fourth and concluding volume which we are to expect from the hands of Dr. Ijzerman (to whom likewise this is obviously a labour of love) will set a fit coping-stone to this monumental work. C. R. B.

THE VOYAGES OF THE CABOTS AND THE ENGLISH DISCOVERY OF NORTH AMERICA UNDER HENRY VII AND HENRY VIII. By JAMES A. WILLIAMSON. *London: The Argonaut Press* 1929. 10×7 *inches;* xiv +290 *pages; and maps.* 38*s*

Forgetful of the vital difference between the discovery of new islands which the old cosmogony could embrace, and the discovery of a new continent or *terra firma* which it could not, posterity has allotted to Christopher Columbus the role of hero of the story of the discovery of America. Amerigo Vespucci is popularly regarded as a man who, by clever publicity methods, stole another man's laurels, while even historians have scarcely understood how great, in contemporary eyes, was the opportunity just missed by the explorers from Bristol. John Cabot was first on the mainland, and had he and his successors pursued their plans of following the coast southward, then the riches of Mexico and Peru had been ours—or so reasoned Robert Thorne and Richard Eden.

The historian whose subject is a popular hero—a Columbus or a Francis Drake—works at a disadvantage: even if he can dismiss his own prejudices, he has to fear that his critical study will be interpreted as an envious belittlement of

a great man. The case of the Cabots has not been prejudged, however, save by one or two specialists, and Dr. Williamson has the pleasant task of rescuing them from some measure of neglect by the general reader, while defending the younger man from unjust aspersions cast upon him by the man who has hitherto known him best, Mr. Henry Harrisse.

That the voyages of the Cabots and of other Bristol men went almost unchronicled, and so were only confusedly remembered, was due to the fact that in geographical knowledge, and consequently in geographical curiosity, England lagged far behind Spain and Italy, and even Germany. It was not until he returned to Spain that Sebastian Cabot found a Peter Martyr, eager to entertain him at his house in order to ascertain what light his travel experience in the far north could throw on certain "secrets of nature." Old John Cabot found no such interlocutor at all.

In the absence, therefore, of any continuous contemporary narrative of the Voyages, Dr. Williamson has found it necessary to cast his work in a somewhat novel form. He prints first of all eighty-one miscellaneous documents—newsletters, patent grants, merchants' accounts, State papers, extracts from contemporary histories—which together contain every scrap of evidence relevant to the early English voyages to America. After sifting these critically one by one, he is able to piece together a coherent story which differs in some important particulars from that hitherto told by historians, including the author himself in an earlier work. The reader is thus given a glimpse behind the scenes, he sees the historian actually at work upon his raw material, and if he is a student (or a layman addicted to detective fiction) he will obtain a maximum of profit and pleasure from this book by resolutely refusing to read Part II (the Elucidation) until he has himself drawn his conclusions from Part I (the Evidence). He need know no more at the outset than that John Cabot certainly made two voyages, in 1497 and 1498, to America, although his exact course is in dispute; also that confusion early arose between John Cabot and his son Sebastian, whether or no by the latter's wilful falsification must be decided; and thirdly, that the evidence allows conclusions to be drawn, rather startling in character, as to what the younger man did and did not do.

In connection with the last point, Document 49 is critical. It is a translation from the Latin of Peter Martyr, made specially for this volume. The student (or amateur detective) will do well to compare this translation with that made by Richard Eden in 1555;* both are coloured by the preconceived geographical notions of the translator, and it is possible that the notions of Eden were closer to those of Peter Martyr himself, so that his admittedly free rendering is to be preferred. The Latinist will, of course, consult the original *Decades*. A second strong clue is hidden in Document 62, and it is possible that confirmation would be found on Gemma Frisius' Globe; but, unfortunately, neither the original nor a copy is to be seen in this country.

The specialist student, however, will prefer to evaluate each document for himself, not forgetting to include the beautifully reproduced facsimile maps, and the well-executed sketch-maps, which are as revealing as the written word. Dr. Williamson makes out an excellent case for reading upon Juan de la Cosa's map of 1500 a record of John Cabot's voyages of 1497 and 1498, and since we have Peter Martyr's testimony to the high contemporary repute of this great pilot's maps, the one in question can doubtless carry the weight which the argument demands.

A further chapter of unusual interest is the author's analysis of the Cabot

*Ed. Arber, *The First Three English Books on America*, p. 161.

patent of 1496. He considers that the phrase giving the patentees liberty to sail "to all parts, regions and coasts of the eastern, western and northern seas" must be interpreted as excluding them from sailing south of Britain. This may be the case, but a different interpretation is possible. There was no recognized "southern sea" until Balboa gazed upon it from a "peak in Darien," while the term "eastern, western and northern seas" corresponded to the Indian, Atlantic and Scythian Oceans, which washed the shores of the tripartite world of current cosmogony. It is possible, therefore, that the patent was intended to include " all seas," as it certainly included "all lands." The point is however of secondary importance, and in his analysis of this patent, and those subsequently granted to the Anglo-Portuguese syndicate which operated in the opening years of the sixteenth century, Dr. Williamson has made a valuable contribution to the history of colonization.

No review of a volume from the Argonaut Press would be complete without a tribute to the exquisite care that has been lavished upon its production, ensuring that it shall be a delight alike to eye and hand. Yet such luxury is costly, and it is to be hoped that the publishers will see their way to issue presently a modest students' edition of a work which must become a standard, both from the standpoint of content and of method of presentation. E. G. R. T.

THE MOST NOBLE AND FAMOUS TRAVELS OF MARCO POLO, TOGETHER WITH THE TRAVELS OF NICOLO DE' CONTI. Edited from the Elizabethan Translation of JOHN FRAMPTON, with Introduction, Notes and Appendices, by N. M. PENZER. *London: The Argonaut Press* 1929. 10×8 *inches;* lx+381 *pages; one illustration in colour and* 11 *maps. Two guineas*

Among the texts of Marco Polo's travels that have come down to us is a Castilian version by Rodrigo de Santaella, published at Seville in 1503, which Professor Benedetto, in his most valuable work, 'Il Milione,' published in 1928, shows to have been made from a text closely allied to the Lucca MS. and, like it, deriving from the Venetian recension, which also provided Pipino's text used by Ramusio. Santaella added a translation of Poggio's record of the travels of Nicolo de' Conti, as they seemed to corroborate Polo's story. This work was translated into English by John Frampton and was printed in London in 1579. The handsome volume under review, excellently printed on Japon vellum, contains a complete reprint of Frampton's now extremely rare book, with an interesting introduction and notes, as well as extracts from Ramusio's and some other texts. In the Introduction Mr. Penzer tells us the relevant facts known about Santaella and Frampton, and gives a summary, with many suggestive comments, of the manuscript tradition and classification of the texts as expounded by Benedetto. This review is particularly useful for readers who have not access to Benedetto's big volume or cannot read Italian. He then proceeds, with the help of eleven useful maps specially drawn for the purpose, to retrace Polo's routes. Mr. Penzer is to be congratulated on having suggested some important amendments of the views held by previous commentators. Some of the proposed identifications, on the other hand, call for further investigation. Here and in his notes the editor has skilfully utilized the results of the vast labour devoted to the elucidation of the travels by Yule and others, as any commentator must necessarily do. In one or two places, perhaps, Yule has been cited in a way that might lead the casual reader to hold him responsible for a suggestion that did not originate from him. For example, the suggestion that Caichu was Kiai-chau was Richthofen's and Wylie's (Yule, II, 19 n.). The proposal to identify Vugiu (or Vughin) with Wu-kiang was Kingsmill's (Yule, II, 184 n.). And it is possible that they may yet prove correct. Yule, moreover, does not attempt to assign to the castle of the Old

Man "a definite locality such as Alamūt"; in fact, he rejects Alamut as being quite out of the way that Polo was following (Yule, I, 148 n.).

Mr. Penzer follows Sir Percy Sykes in holding that Polo did not go down the Tigris via Mosul and Baghdad to Basra, and suggests that he travelled by Tabriz, Saveh, and Yezd to Kerman; but there seems no ground for supposing that he went through Bafq. Camadi (? the Comada of Behaim) has been satisfactorily identified by Abbott, Sykes,) and Houtum-Schindler. Could Dogana be connected with the Damghān marked by Idrisi close to the Oxus, north by east from Balkh ? (see Miller's Tafel 28, Paris MS.).

In the newly discovered Z text (MS. Y 160 P.S., Biblioteca Ambrosiana) Carachoco is named as the principal city of the Icoguristam province under the Great Khan. The identification of this town, first suggested by Mr. Penzer, with the ancient Khara-khoja (? the Karakuia of Strahlenberg's map), and not with Khara-khoto, as proposed by Benedetto, is important as definitely fixing another site. It must be noted, however, that Rashidu'd-din, the contemporary historian, writes that Khara-khoja "lies between the two states, and maintains neutrality," which can only mean that it was not subject to the Great Khan. This identification also helps us to some extent in locating Polo's Ghinghintalas, a name that has not yet been satisfactorily explained.

As regards the itinerary from Yunnan into Burma, it seems unlikely that Polo went as far as Tagaung. Mr. G. E. Harvey, in his 'History of Burma,' throws some light (pp. 65–67, 336) on this invasion from China, and he is apparently satisfied that the Great Khan's army did not get beyond Kaungsin in the Bhamo district. It may be added here that, as Yule pointed out, the spelling Cardandan is misleading: it should be Çardandan (as in Benedetto's F text), *i.e.* Zar-dandān.

Polo's route from Cacianfu to Coiganju seems still doubtful in places, in spite of the suggestions made. If Singiumatu be Tsi-ning-chau, the obvious difficulty of identifying Tadinfu with Yen-chau, as Yule noted, is that Tsi-ning-chau is not three days' journey from Yen-chau; moreover, it could not correctly be described as three days' distance to the *south* thereof (and the texts agree as to the direction). As to Linju (Odoric's Lenzin), it looks as if the town had disappeared as a result of the changes in the course of the Hwang Ho, which enhance the difficulty of tracing old sites in this region. The fact is that many problems still await solution: it is possible that some may never be satisfactorily solved, such as the route from Kuhbanan to Shibarghan, in regard to which there appears to be a lacuna in the texts. C. E. A. W. O.

THE LIFE AND VOYAGES OF CAPTAIN COOK. By MAURICE THIÉRY. *London: Geoffrey Bles* 1929. 9×6 *inches:* x+238 *pages; illustrations, and end-page maps.* 15*s*

M. Thiéry seems to have caught from M. André Maurois the habit of writing biography—especially the biographies of notable Englishmen—in semi-fictional form. By way of presenting "as animated a portrait as possible" of Captain Cook without drowning it "beneath a flood of erudition," he narrates a few of the facts about Cook's early life in an imaginary conversation between the boy Cook and a Yorkshire carter, and incidentally characterizes the grocer's shop in Staithes as a "gastronomical temple." Such a beginning scarcely inspires confidence in the usefulness of the book for serious students, nor is it atoned for by what follows. One does not care to accuse M. Thiéry of actual ignorance; but his narrative is so airily casual that, if you accept his phraseology as it stands, you will believe that Cook's movements after he left Tahiti on the first voyage were entirely of his own choosing; that he anchored in Botany Bay, his first Australian landfall, on April 19; that the green tree ant is black; that kangaroo flesh is delicious; and that

the Barrier Reef lies west of the coast of Queensland; all this within twenty pages. Such work is obviously useless to readers in search of the truth—among whom, by the by, M. Thiéry deliberately ranks himself in his Author's Note. But he has taken his responsibilities too light-heartedly, and no amount of animation will compensate for his persistent superficiality. The book, in truth, belongs to the decoy-duck class—a very necessary type so long as it makes no higher pretensions—from which school prizes and birthday presents may be advantageously chosen, in order to interest with easily digestible phrases young folk of a naturally unstudious disposition; it makes Cook's adventures interesting enough, but is merely an appetizer, not solid food. A. J.

AN HISTORICAL GEOGRAPHY OF EUROPE, 800–1789. By J. M. THOMPSON. *Oxford: Clarendon Press* 1929. 8×5 *inches;* vi+152 *pages; sketch-maps and diagrams.* 5*s*

Mr. Thompson writes primarily as a teacher of history who has found it useful frequently to look at the map when working with his pupils. He reviews the main tendencies of European history and discusses the geographical considerations they suggest; for example, the generalization that the history of France exhibits "a centralized government and a decentralized people," the "backwardness" of Spain, the "disunity" of Germany, the Rhine conflict, and so forth. As wars and boundary problems must figure largely in such a sketch, his interest is chiefly in the lie of the land. There is little consideration of climatic conditions as a whole, a neglect which perhaps leads him to over-emphasize the isolation of Spain, through treating it as African rather than Mediterranean in environment. One of his geographical statements contains a mixture of errors—"the map of central Asia shows a belt of pasture lands lying between long. 50 N. and 35 S., with forests to the north and deserts to the south, and stretching all the way from lat. 110 to 40 E." His remarks on the condition of primitive Germany are likely to give the impression that the country was one gigantic forest. The migrations were due in part to the growth of the population straining the resources of the open areas, before the tribes possessed implements with which to attack the forests. The development of trade routes is well sketched, and a good feature is the attention paid to internal communications, several road maps based upon contemporary itineraries being included. The omission of the British Isles from the survey is surprising. The book contains many valuable suggestions which should prompt young students to carry the study of maps further for themselves.
G. R. C.

A NEW REGIONAL GEOGRAPHY OF THE WORLD. By M. I. NEWBIGIN, D.SC. *London: Christopher's* 1929. 8×5 *inches;* xxii+432 *pages; maps, diagrams and illustrations.* 5*s*

When the specialist teacher enters the schoolroom the text-book often disappears, an unexpected sequence of cause and effect that has had unfortunate results: boys and girls leave school with a knowledge which, if vivid, is disorderly and fragmentary; they enter the University unable to use a text-book to advantage. That the specialist should be impatient of the text-book is easily understood; he is too full of his subject to mould his treatment of it to a pre-determined form. Yet he is the very man who complains that the examination syllabus is too wide, that he has no time to cover the ground. The "omnibus" teacher, who simply divides up his text-book according to the number of weeks at his disposal, and sees that his pupils know its contents, gets through comfortably enough: his lessons, however, are as wearisome and uninspiring as those of the specialist are stimulating. The remedy for the defects noticed is simple enough: to supplement

the oral teaching by a text-book written in straightforward narrative style to be read independently by the pupils from cover to cover. So far as geography is concerned, there is no escape from the fact that the whole world ought to be covered, and covered on a scale related to the relative importance of its parts; hence the text-book must be a world-geography, and the teacher may choose between one that deals with world-distributions—of climate, vegetation, crops and the like—and one which deals with the world region by region. Since the pupils are to read alone, he must choose also a book by an author whose name is a guarantee of accurate presentation. The 'New Regional Geography' of Dr. Newbigin will exactly fulfil his requirements, while usurping none of his functions: its style and arrangement are sufficiently conventional to fit any normal syllabus, yet its special emphasis on plant-life and agriculture lends it individuality and interest. Its price, too, only five shillings for 432 pages, is as it should be.

E. G. R. T.

SAIL: the Romance of the Clipper Ships. Volume II. Pictured by J. SPURLING. Storied by BASIL LUBROCK. Edited by F. A. HOOK. *London: Blue Peter Publishing Company* 1929. 13 × 10 *inches;* 152 *pages; illustrations and map. Three guineas*

This second volume contains descriptive articles by Mr. Basil Lubbock, and coloured plates from the brush of Mr. Spurling, of many of those clipper ships and traders that graced the seas in such numbers in the latter part of last century, but are to-day almost extinct. It is a matter for satisfaction that these marvellous creations should be described and illustrated in a manner that ensures for them a worthy place in the history of sail.

Mr. Lubbock's graphic descriptions of typical vessels and voyages bear eloquent testimony to the sea-worthiness of the craft themselves, and to the navigators and seamen who commanded and manned them. Mr. Spurling's masterly treatment of his subjects enables the reader to envisage the noble craft of which he reads, and cannot fail to make him deplore the passing of so much beauty from the seven seas. A notable omission from the drawings is the *Cutty Sark*, although that vessel is mentioned frequently in the text. But this is perhaps pardonable, as this famous clipper is herself preserved at Falmouth as a beautiful example of the deep-water sailing craft of other days, at the epoch of their highest development.

That but few of these vessels succumbed to old age is a matter for notice. Most succumbed in the end struggling with the elements, whilst not a few passed out in the World War—changed however on occasion from things of beauty to "most hideous monstrosities in the way of cargo carriers."

To the student this volume can be commended as an instructive and thrilling record of famous deep-water sailing ships. As a memorial to sail, it is superb.

M. TI. T.

CLIMBS AND SKI RUNS: Mountaineering and Ski-ing in the Alps, Great Britain and Corsica. By F. S. SMYTHE. With a Foreword by GEOFFREY WINTHROP YOUNG. *Edinburgh and London: William Blackwood & Sons* 1929. 9 × 6 *inches;* xx + 308 *pages; and illustrations.* 21*s*

Though not of any strictly geographical interest this remarkable volume should not pass unnoticed in the *Journal*. Mr. Smythe has written a book which will be welcomed by all mountaineers and all mountain lovers. He has achieved a remarkable suppression of self and of expression of mountain forms. He is a modern of the advanced school of mountaineers, but he sticks to his mountains and avoids introspection. Nor, while a strenuous advocate of extreme daring, is there ever a word of carping at the more cautious methods of his predecessors.

His style is remarkable: vivid without embellishment, exciting but without exaggeration.

The chief interest of the book, of course, centres round the great new climbs on the Brenva–Mont Blanc de Courmayeur face of Mont Blanc, so brilliantly conceived by the author and Mr. T. B. Blakeney, and executed in 1927 and 1928 with Professor Graham Brown, F.R.S. as his sole companion. It is not probable that any mountain ascent has ever been accomplished calling for a greater display of the highest degree of mountaineering skill than was necessary on these two occasions. Both routes are extremely long and exposed, and call for the continuous exhibition of the highest skill and sureness of judgment. Once launched on the adventure retreat is barely possible. On such a face human endurance could scarcely outface a storm: and for accounts of alpine storms those passages describing the scenes from the Brenva bivouac, from the Red Sentinel, and from the Pétéret ridge, will remain hard to beat.

The author is equally happy in his descriptions of ski-ing in the lower ranges of the eastern Alps, in the British Hills, and in Corsica. The illustrations are numerous, apposite, and very beautiful. The book is quite likely to become a classic, but the publishers' temerarious reference to Whymper should be removed from the paper cover. T. G. L.

CARTE INTERNATIONALE DU MONDE AU 1,000,000e (1/M or 1 inch to 15·78 stat. miles). Sheets: N. J–33, Palermo, 1925; N. K–32, Firenze, 1926; N. K–33, Roma, 1926; N. L–32, Milano, 1927; N. L–33 Trieste, 1928. *Firenze: Istituto Geografico Militare.* 18 × 19 *inches*

We have received, from the Central Bureau of the International Map of the World, a second set of the sheets of this series, covering Italy. These sheets are printed and published by the Istituto Geografico Militare at Florence, under the direction of General Vacchelli. The first set of sheets was presented to the Society at the time of the International Geographical Congress, in July 1928.

The sets include the whole of Italy and Sicily, but only the northern half of Sardinia. They consist of Palermo, N. J. 33, published in 1925; Roma, N. K.33, 1926; Firenze, N. K. 32, 1926; Milano, N. L. 32, 1927; and Trieste, N. L. 33, 1928. The set just received is somewhat more heavily printed, and the layer tints differ a little from those of the first set, but the sheets appear to be printed from the same plates.

Taking the five sheets as a whole they admirably illustrate the merits of the International Map, and the different sheets give a very graphic and accurate impression of the various parts of Italy that they represent.

THE MONTHLY RECORD

THE NAUEN TIME SIGNALS

On 3 December 1929 we were informed by Colonel Craster that Nauen was sending the Rhythmic signals on the New International pattern instead of the pattern peculiar to Nauen, which it had followed for so many years. The change is announced in *Minor Corrections to Admiralty List of Wireless Signals*, 1929, for the week ending 20 December 1929. The schedule for Nauen on pages 23 and 31 of *R.G.S. Technical Series No.* 3: Wireless Time Signals for the Use of Surveyors (Third Edition, April 1929), must therefore be corrected.

CATALOGUE OF SURREY MAPS

We have received from its author, Mr. Henry A. Sharp, of the Croydon Public Libraries, 'An Historical Catalogue of Surrey Maps' (Croydon: Public Libraries Committee, 1929, 3*s* 6*d*), which forms a useful addition to the growing list of such catalogues, of which those of Sir George Fordham and Mr. Chubb (late of the British Museum) are among the best known. In a general way it follows the pattern set by its predecessors, but is printed in unfortunately small type, the descriptive matter supplied by the author after the title of each map being in particular not so easily legible as could be wished. Much care and time have obviously been expended in its preparation, and it no doubt gives a fairly complete account of the printed maps of the county from about 1600 to the present day, although (wisely perhaps) no attempt is made to catalogue each successive issue of the same map. The claim made in the preface that "it is believed that no important map is omitted altogether" was a somewhat bold one, and certain omissions can be detected on a rapid glance through the list. The author has missed, for example, the notes which have appeared in the *Journal* on recent acquisitions of early county maps for the Society's collection, and no mention is made of the original issue of Norden's map of the County (1594) though the second edition of *c.* 1604, of which a facsimile was published by Messrs. Ellis of Bond Street in 1904, is duly entered. Nor does the author know of the original, owned by the Society, of the Surrey map belonging to the anonymous series of *c.* 1602, described in the *Journal* in October 1926, but attributes the Surrey in this set to the much later map-seller, Peter Stent, whose re-issue is entered under its approximate date of 1665. We miss also a more important map of a later date—Senex's four-sheet map of the County on the mile-to-the-inch scale, published in 1729 "from an actual survey," and one of the earliest county-maps to appear in so imposing a style. The omission is here less intelligible, as a copy has been in the British Museum for many years, being entered in the printed catalogue issued in 1885. The arrangement, as in other lists of the kind, is chronological, the scale and size of each map are noted, and there is an index of the names of authors, publishers, and engravers.

VEGETATION OF THE SOUTHERN PENNINES

A lengthy paper by Dr. T. W. Woodhead on the "History of the Vegetation of the Southern Pennines" has appeared in the *Journal of Ecology* (vol. xvii, No. 1, 1929). The author indicates that the vegetation of this section of the Pennines, that is, between the Aire Gap and the Peak, has received special attention ever since the study of ecology first took shape some thirty or forty years ago, so that its history can be traced with more assurance than would be the case in less well-known regions. During the maximum phase of the Ice Age the main ridge formed a nunatak, and our temperate flora was exterminated. There are no records of Arctic species from this area such as we have from the Cumberland

fells, Snowdon, and the Grampians, owing to the absence of conditions favouring preservation. Later, during the so-called Boreal period, when the climate was warmer and drier than at present, there were forests, predominantly of birch, but with hazel, alder and oak as subdominants, and occasional pine and elm. The preservation of pollen grains in the peat has permitted the certain identification of these trees. Then the climate began to grow wetter and approach the conditions of the present day, so that degeneration of the forests set in with accumulation of peat.

The sandstone and shales of the Millstone Grit and Coal Measure Series are notoriously deficient in lime and other alkaline bases, and when leaching, following the increase of rainfall, further impoverished the soil, the natural decomposition of humus was arrested, so that the soil became acid, badly aerated, and highly charged with organic matter. Thus peat would form and accumulate, and a characteristic moorland vegetation appear. The chief peat formed in the Pennines is cotton grass (*Eriophorum vaginatum*). At lower, drier, levels the degeneration of the forest has been succeeded by heather (*Calluna*) moors. These two types of moor were distinguished in early times by names which still remain, the cotton-grass moors of the summit plateau being called Mosses, and the drier heaths Moors. The activity of man has always helped to depress the tree-line. At the present day the great smoke clouds from the adjoining industrial region coupled with the high winds would effectively hamper regeneration of the forests, but in any case they could hardly maintain themselves under present climatic conditions at the higher levels. Latterly there has been a tendency to convert by artificial drainage the cotton-grass moors into heather moors, as affording better food for grouse.

FLOW OF WATER THROUGH THE STRAITS OF DOVER

Dr. J. N. Carruthers of the Fisheries Laboratory, Lowestoft, discusses the "Flow of Water through the Straits of Dover as gauged by continuous current-meter observations at the Varne Light-vessel" (50° 56′ N.—1° 17′ E.) (*Ministry of Agriculture and Fisheries Fishery Investigations*, Series II, vol. xi, No. 1, 1928). He describes an instrument, called the Drift Indicator, with revolving cups, which records how much water from different directions passes the light-vessel during any given period, so that the residual or net direction can easily be obtained. In other words, it affords "*direct* information as to the flow of water over and above the oscillatory streams due to the tides—without the necessity of eliminating the periodic tidal water movements mathematically."

The preliminary results, which are concisely summarized, on the exchange of water between the English Channel and North Sea, are based on several years' observation, and it is believed that the work will eventually prove of practical importance, especially in connection with fisheries. The net or residual movement of the sea through the Straits is, of course, fundamentally a meteorological effect, and the work is copiously illustrated with weather charts of the Air Ministry. With the prevalent winds from south-west and the seas in communication with the Atlantic it was to be expected that the general drift through the Straits would be from Channel to North Sea. The precise facts are stated thus: "All the varying currents which *did* occur during our sample year effected the same overall transport of water from Channel to North Sea as would have been brought about by a constant daily flow of 2·7 miles from Channel to North Sea." The two extremes of experience during the years of observation with the instrument were a flow of 16·8 miles a day from Channel to North Sea, and a flow of 11·9 miles a day from North Sea to Channel. The "mileage" run of the Flood stream has been known to attain 10·98 with a maximum speed of 2·9 knots, whilst

that of the Ebb stream can reach 8·6 with a speed and strength of 2·24 knots. Summer is the season when the flow of water from English Channel to North Sea is least, autumn that when it is greatest. Winter with its stormy south-west winds *should* be the season when the north-eastward flow of the water is greatest, but as it is also the season when the strongest reversals due to north-east winds occur, the net transport of water in the said direction is less than in autumn. This, of course, reflects the fact that winter is the season when storm winds from all directions are strongest.

Under certain meteorological conditions, when the southern North Sea becomes "flooded," there is no flow through the Straits.

TOWNS OF LOWER SAXONY

Among recent monographs in the German series, *Forschungen zur Deutschen Landes- und Volkskunde*, is a study by Dr. Hans Dörries of the foundation and plan (Formenbildung) of the towns of Lower Saxony. Though the latter subject may appear too specialized for any but local students, the investigation throws considerable light upon the development and nature of mediaeval trade routes. The main body of the work is an alphabetical list of 289 towns and market-places, with particulars of their early history, first privileges, etc. Lower Saxony—here, roughly, the basins of the Ems and Weser, and left bank of the lower Elbe—presents several internal contrasts, between the north-western slopes of the Harz, the diversity of the "Mittelgebirge," the level plains of thick glacial detritus and the low alluvial coastal strip. These contrasts are reflected in the distribution of the towns. Though the heavily forested mountain area was settled only in the early Middle Ages, and the heathy ridges of the lowlands had borne a considerable population from Neolithic times, the distribution of towns is thicker in the former area. This is even the same for the ninth and tenth centuries. Towns, of course, in this region are of comparatively late date; the earliest dated market privilege is from the year 833. Dr. Dörries concludes that their small number can only be due to lack of records, as he considers them insufficient to serve so wide an area. He wisely refrains, however, from speculation as to where the others requisite should be looked for. It might be doubted whether this number is really too small, having regard to the comparatively late settlement of the region, the transit nature of the trade, referred to later, and the closer concentration of the towns in the more elevated country, all of which suggest that they did not spring up to meet the wants of a local population alone. Dr. Dörries reconstructs from the available evidence the routes of traders and examines their relation to geographical conditions. The general impression retained from his sketch is the extraordinary difficulties against which early commerce on land struggled; the preference of bodies such as the Hanseatic League for sea-trading is easily understood. Most of the rivers in their lower courses experience severe winter flooding: on the coast, winter travel was also impossible until the construction of dykes. Even in summer many areas of the plains were isolated by the stretches of marshy alluvium. The connection between Osnabrück and Bremen in winter was not secured until *c.* 1070, with the building of causeways across the intervening moors. In the Harz roads can only be said to have existed at the close of the Middle Ages. Most of the towns were on navigable rivers, but more important was their function as crossing-places. The most important through routes were from Emden, through Bremen and Braunschweig, to Magdeburg, where traders established contact with the Slavs, and those uniting the Low Countries and the Rhine towns with the Hanseatic centre Lübeck. He gives, of course, no quantitative estimate of the traffic along these routes, but it is unlikely, in view of the obstacles, that it rivalled the sea-borne trade past the coast.

HOAR-FROST AND GLACIER-GROWTH IN NORWAY

Professor H. W. Ahlmann, of the University of Upsala, is pursuing glaciological researches in the Horung Massif, in Jotunheim, Central Norway, and in connection with these researches the Norwegian Meteorological Office under the direction of Dr. J. Bjerknes has built a small observatory on the summit of Mount Fanaråken, at 2050 metres (a little over 6000 feet) above sea-level. In a paper entitled "On the Formation of Hoarfrost and its relation to Glacial Growth" which has appeared in *The Journal of Geology* (vol. xxxvii, No. 3, 1929), Professor Ahlmann describes the immense formations of hoar-frost during a stay of nine days at the observatory in June–July 1928. The weather was unusually stormy for the season with strong south-west winds, and the rapidity of deposit was greatest during the height of the storm that raged between June 29 and July 2. Not only was the hoar-frost deposited on objects projecting above the ground, but the great snowfield that clothed the summit was also covered with a carpet of hoar-frost leaves. The most rapid growth occurred as a rule on surfaces covered neither with snow nor rime. A study of the huge snow-drifts that covered both the south-west side of the observatory and corresponding slopes of the summit showed that they probably consisted mainly of hoar-frost. Professor Ahlmann draws attention to the similar vast accretions of hoar-frost that have been observed at the Ben Nevis Observatory in Scotland, and the Brocken in Germany, and raises the question whether a much larger proportion of the snowfall at mountain levels in Europe than is generally supposed is not due to this source. He points out that during his stay at the Norwegian observatory the peaks of the Horung massif were seen to become shrouded in an ever-thickening white gown notwithstanding that the actual fall of snow during the period was trifling. He calculates that the yearly precipitation on such great glaciers as the Svartisen and Jostedal must amount to nearly 6000 mms. (240 inches), whereas the meteorological stations near these glaciers only indicate some 2000 mms. (80 inches). He considers that the difference between these figures represents in large measure the formation of hoar-frost, which must thus play an important part in the feeding of the glaciers.

Apart from the single reference mentioned above, nothing is said by Professor Ahlmann about *rime*, which technically is a mist or fog-deposit which normally occurs in the same type of weather among the mountains as the hoar-frost deposits in question. There seems little doubt that he is here using "hoar-frost" in the technical meteorological sense of a deposit freezing out of the air without the medium of fog, and it is thus surprising that he is at no pains to make the distinction between rime and hoar-frost clear as applying to the observations described. It is fairly certain that mountain mists do considerably swell both the rainfall and snowfall according to conditions of temperature, but it appears that the increment from dew or hoar-frost action, as described by Ahlmann, has not hitherto been suspected of playing a very important part.

SAN'A, CAPITAL OF YEMEN

A full description of San'a, with special reference to its physical setting in the region in which it is placed and the effect of this on the life of the inhabitants, is given, from personal knowledge, by C. Rathjens and H. von Wissmann, in the last number for 1929 of the *Zeitschrift* of the Berlin Geographical Society. The paper includes a sketch of San'a's history and is accompanied by a map of the region and a detailed plan of the city, based on a survey by compass and pacing, helped also by air photographs. The authors lay stress on the physical division of Central Yemen into a series of parallel belts in accordance with the tectonics and climatic conditions of this western border of the Arabian desert plateau. Six

such belts are distinguished: (1) the coast-plain of the Tihama; (2) the marginal elevated block; (3) the outer zone of depression; (4) the inner elevated block; (5) the inner zone of depression; (6) the eastern highland. Each of these has its own climate. To the heat and aridity of the Tihama succeeds the most favoured belt of all (No. 2), which receives both orographic and zenithal rains, and is the most thickly peopled and best cultivated—the especial home of the coffee tree. Being more or less in rain-shadow the next zone receives only zenithal rain, and agriculture is limited to terrace-cultivation in the valleys. The next (No. 4) gets some orographic as well as zenithal rain, and terrace-cultivation is possible on its western side. The inner depressed zone again depends solely on zenithal rain, having lesser rains in spring and greater rains in summer. Permanent running water occurs only on the slopes bounding it on the west, but the rain which falls on the floor of the depression is conserved by the loess-like deposits which cover it. The climate is fine and healthy, and this zone is in part better settled than No. 2. The eastern highland, which reaches heights of 3400 metres, is furrowed by valleys on its eastern margin, and oases with date groves occur where these debouch on the unknown desert beyond. In early times, when an important trade route ran north through this eastern zone, it was the seat of the most ancient civilization, but the centre of gravity was afterwards shifted west, and it was in the inner zone of depression that San'a rose to importance. A glowing account is given of the intensive cultivation of the plain of San'a by irrigation from wells, which permits three harvests in the year. The city has the form of a figure 8, being rather two cities than one. They lie east and west, their extremities 5 km. apart, and it is to the eastern, the old city, that the name San'a properly belongs. The topography and buildings of the city are described and illustrated by photographs, the life of the people being also dealt with in some detail.

THE EVERGLADE KEYS OF FLORIDA

A study of erosion and vegetation of the Everglade Keys of Southern Florida is contributed by Dr. J. K. Small to the *Scientific Monthly* for January, with special reference to the relation existing between the plants and their habitat. The Everglade Keys rise like islands from the low-lying and periodically flooded plain of the Everglades, and are in some respects the counterpart of the Upper and Lower Florida Keys which rise from the sea between the Strait of Florida and the Gulf of Mexico. While the middle group—the Upper Florida Keys—is composed of coral limestone, the rock of both the other groups is Oolitic, known in the Everglade Keys as Miami limestone, a more widely extended formation which there attains its greatest altitude, though this averages only a few feet, but is sufficient to enable the islands to support a flora almost entirely different from that of the surrounding country. A continuous plant-covering seems to have been maintained throughout the movements of elevation or depression during Pleistocene and Post-Pleistocene times, and, so far as the native flora is concerned, the Keys represent a small tropical area isolated on the mainland of the United States, with strong relationships to the flora of Cuba and the Bahamas. But they offer a strong contrast to their neighbours, the Upper Florida Keys, in the large extent to which they are covered with pinewoods, while the more southern group is clothed entirely with the broad-leafed "hammock" vegetation,* which is the second main type in the whole region of Southern Florida. The forms of surface erosion are somewhat remarkable, the chemical action of the humus accumulated on the floor of rock having given rise to erosion cavities (sometimes as big as a small house) by reason of the uneven composition of the

*This is an Indian term, and has nothing to do with the word "hummock."

limestone. This is not so apparent in the pine-lands, where the hollows have been filled with débris, but it is revealed by closer examination, and from the similarities between the two formations in this respect Dr. Small concludes that, like the Upper Florida Keys, the whole surface was originally clothed with hammock vegetation. The reduction in area which this has suffered is ascribed to forest fires, started by the Indian hunters who frequented this region. Where the original plant covering was thus destroyed plants resistant to fire appeared, particularly the Carib-bean-pine (*Pinus caribaea*), with two species of "Coontie" (*Zamia*) and the saw-palmetto. The Coontie remains unharmed by reason of its underground stem, while after the passage of fire the blackened prostrate trunks of the palmetto soon develop a new crown of leaves and inflorescence. The flora of the hammocks is not extensive and is typically that of insular tropical America, while the pine-lands have received exotic elements both from north and south. Among them trees and shrubs representative of the hammocks struggle for existence, but in a stunted form, developing their trunks wholly within the erosion holes above referred to.

CLIMATE AND FLORA OF PATAGONIA

In the last three numbers of *Petermann's Mitteilungen* for 1929, Professor H. von Ihering discusses the climate and flora of Patagonia in geological time. The conclusions at which he has arrived after many years' work lead him strongly to combat Wegener's theory of continental drift, as applied, at least, to the past union of South America and South Africa. He criticizes it upon both geological and palaeobotanical grounds. It would be remarkable if the two continents had preserved their outlines from Cretaceous times; but, as Professor von Ihering shows in some detail, South America at least has undergone considerable changes since. At the end of the Tertiary period, for example, Patagonia was united to the Falkland Islands and also to Graham Land. These bridges were broken down in late Quaternary times only. Further evidence that the present coast-line is not earlier than that may be gathered from the formation of the Patagonian tableland, the existence of early Tertiary marine sediments, the wide distribution of fluvioglacial boulders of Quaternary Age, and the signs of elevation to one or more hundred feet. It is, therefore, impossible to attach importance to the fact that the present coast-line may be made to fit into that of South Africa. As a palaeobotanist, he is equally critical of Wegener's theory, and his conclusions form the main body of these articles. Wegener and Irmscher argue from the identity of the Cretaceous flora of South Africa and Patagonia, and explain subsequent changes in climate and vegetation by the displacement of the polar axis. Thus, at the time when Europe was undergoing Pleistocene glaciation, South America must have been enjoying a very warm climate, and, consequently, a "tropical" fauna. This conflicts directly with the geological evidence referred to above. It also seems to demand a comparatively rapid alteration of the polar axis between the Pleistocene and the present, compared with the slow change throughout Tertiary times. Von Ihering examines carefully the Cretaceous fossils, the oldest flora in Patagonia, and concludes that it is similar to the North American "Dacota" flora, though younger. He then works out the possible lines of distribution of this flora from North America. The earlier and richer elements are assumed to have reached southern South America by a "sunken land" in the Pacific: later, "antarctic" elements arrived via Asia, Australia, and the Antarctic land bridge. This flora did not reach South Africa, which at this period was isolated from the north. Throughout Tertiary times it was without contact with the "Archihelenis" floral region, comprising Brazil and South Africa. It was destroyed, with the fauna, by the Pleistocene Ice age. With the retreat of the ice, the Antarctic land

bridges broke down, and the cold Humboldt current flowed up the east coast, producing a considerable fall in temperature, and the retreat of the vegetation, especially the mangrove "formation," from the Rio Negro to Santa Catharina. Some elements, however, maintained themselves in spite of the degeneration of the climate, especially upon the western coast. It will be seen that von Ihering's theory of migrations of flora conflicts with the sudden movement of broad belts demanded by Wegener's hypothesis. The former concludes that the union of South Africa and Patagonia can derive no support from the historical development of the flora, and expresses the opinion that there is no more reliable guide to the past distribution of land and water on the Earth than the history of life.

CIRCULATION OF THE INDIAN OCEAN

The Institut für Meereskunde of Berlin University is showing praiseworthy activity in issuing oceanographical studies, which follow each other in quick succession. One of special importance is a careful discussion by Dr. Lotte Möller of the circulation of the Indian Ocean, on the basis of all available material (*Veröffentlichungen*, Neue Folge, Geogr. Naturw. Reihe, Heft 21). A similar study of the circulation of the Atlantic had been undertaken by Prof. A. Merz before his regretted death during the course of the *Meteor* Expedition, and that writer had hoped to extend his examination of the data to the other oceans as well. It has now fallen to his former pupil, Dr. Möller, to carry out his intention as regards the Indian Ocean. The material used includes not only that obtained by great expeditions like those of the *Challenger*, *Gazelle*, *Valdivia*, *Gauss*, etc., but also the less-known work of the survey ships of the British Admiralty—*Egeria*, *Penguin*, *Stork*, *Sealark*, etc. All the observations on temperature, salinity, winds, currents and so forth are analyzed in detail, but we can here refer only to the general results. They are put forward provisionally, as the need for greatly extended work in the field is recognized. One of the marked factors in the circulation is the fourfold stratification of the water of the Indian Ocean, a sub-tropical surface layer with relatively high temperature and salinity being underlain by a colder and less saline mass of Antarctic water, while below this is another body of sub-tropical water derived from the equatorial belt, with increased temperature and salinity, and, still lower, a bottom stratum of Antarctic water. The surface currents show a distinct zonal arrangement, in belts running generally east and west, and within the tropical area the deep movements follow the same general plan, though with a meridional component. Four separate lines of convergence are established, also running generally east and west, and described as the tropical (in about 8° S.), the sub-tropical (running generally between 30° and 35° S.), the sub-polar (between 43° and 53° S.), and the polar (about 60° S.). Only the second shifts its position decidedly according to season, running as far north as 25° in January, and as far south as 35° in July. The relation of the deep currents to these lines of convergence is briefly discussed. One section of the paper considers the relation of the Indian Ocean circulation to that of the oceans on either side. It is pointed out that the low density of the upper layer of the Indian Ocean causes its level to be higher than that of its neighbours, giving rise to the strong surface currents towards these in both directions. As regards the lower layers, in 40° S., the pressure-gradient appears to be from the West Atlantic both eastward and westward, so that the West Atlantic appears to be a region of convergence, the West Pacific one of divergence. In 55° S. the movement seems likewise to be from the Atlantic to the Indian Ocean, so that the deep water here too is under the régime of an interoceanic circulation.

GREENLAND'S FORMER CLIMATE

In a discourse to the Royal Institution on 25 January 1929 and published in *Nature* for March 23, Prof. A. C. Seward contrasts the Greenland of to-day with the Greenland of Cretaceous times, when the chalk rocks of England were being deposited beneath the sea. Greenland, an ancient crustal block of igneous rocks with sedimentary rocks on the coastal fringe, is for the most part buried beneath an ice-sheet of unknown thickness extending to a height of some 9000 feet above sea-level. The northern limit of trees is close to Cape Farewell, where birches, alders, and a few other trees reach a height of 12 to 18 feet. The flora of the country has been fully described by Prof. Ostenfeld (see *Geogr. Journ.*, vol. 67, p. 320). At the height of the last Ice Age, known as the Pleistocene Glaciation, some forty thousand years ago, the Greenland ice was the nucleus of an extended glaciation which embraced most of the British Isles, then in much the same condition as Greenland is to-day. The fossil flora of Greenland, however, shows a much richer vegetation than prevails now, the Cretaceous vegetation indicating forms showing affinities with magnolias, tulip trees, bread-fruit trees, oaks and other forest trees. It is reasonably inferred that there were no glaciers during that remote period, although the mountains in summer probably held patches of winter snow, much as they do here and there in the Scottish Highlands to-day. Concerning the cause of this warm Cretaceous climate Prof. Seward rather inclines towards Wegener's theory of continental drift, though admitting that it is difficult to believe that the greater part of Greenland in the Cretaceous period was not as now well within the Arctic circle. If an Arctic Cretaceous Greenland were really the fact it would be necessary, he points out, for the southern vegetation referred to above to have adapted itself to the long winter night. And in connection with the general question of organic adaptability we are glad to note the strong word of warning which Prof. Seward addresses to geologists and palaeo-climatologists against inferring too much from biological evidence. We have no right to assume that species do not alter their reaction to external factors in the course of ages. It is highly probable, on the contrary, that they do. Nor do closely allied forms always show similar responses. Hence attempts to evaluate climatic changes quantitatively from the fossil records of the rocks are wholly untrustworthy.

MARL FORMATION IN LAKES

The influence of the thermal stratification of the water upon the formation of different kinds of deposits has been investigated by Mr. E. M. Kindee, of the Geological Survey of Canada (*Geographical Journal*, vol. 72, p. 94). He has lately followed up his researches on this subject with special reference to the formation of the calcareous deposits known as marl (*Journal of Geology*, vol. xxxvii, No. 2, 1929). The paper compares the effects of thermal stratification in Lakes Huron and Ontario with those in small lakes in the Ottawa valley. It is shown that the warm surface water commonly found in the Great Lakes during the summer has several times the thickness of the similar zone in relatively small shallow lakes. While the bottom temperatures of the two kinds of lake are much the same the surface temperatures in the large lakes are lower than in the small ones, elevation and latitude being about the same. With increasing elevation thermal zoning becomes indistinct and may disappear entirely at the end of a valley glacier. It is found that the thin warm surface layer, saturated with carbonate of lime, of the small lakes in summer is essential to the formation of marl, which, on the other hand, is nowhere forming in the Great Lakes, nor in small ones above 5000 feet in Southern Canada. It is, however, often found in small lakes in close association with the Great Lakes, or separated by only a sandbar from the larger body of

water. The author has failed to learn of any marl formation in latitudes north of 60° either in North America or in Europe, the reason being attributed to the low mean summer temperature and lack of well-developed thermal stratification. He notes that calcareous terrestrial deposits in North America are forming much farther north than similar marine deposits. The region of active deposition of the materials for marine limestones lies south of 35°, whereas sediment, which will become fresh-water limestones are accumulating as far north as 55°.

BIBLIOGRAPHIE GEOGRAPHIQUE, 1928

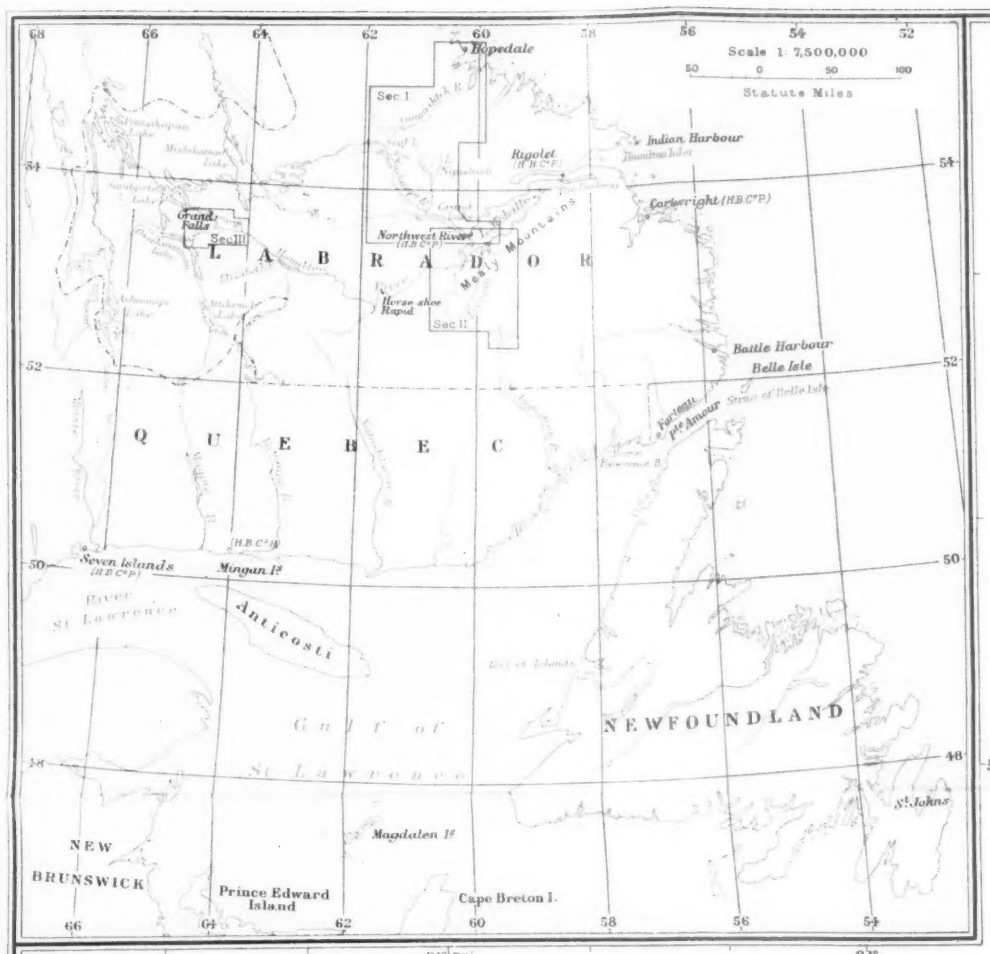
The volume of the 'Bibliographie Géographique' for 1928, the thirty-eighth of the series published by the "Association de Géographes Francais," is now in the press, and should be ready for distribution in March. This volume, which classifies, usually with a brief analysis, all the important geographical publications—books and periodicals—of 1928, is appreciably larger than any previously issued. It contains over three thousand entries, many of which comprise numerous separate bibliographical references, and the index to authors has 6000 names. As in previous years, this Society has organized the British contribution, and American, Italian, and Egyptian bodies have also co-operated. The special price for the 'Bibliographie' in the British Isles and the Dominions, if ordered through the Society, is 8*s* 6*d* post free. Orders should be sent without delay to the Chief Clerk, at the House of the Society. The volumes for the years 1924–1927 may still be obtained at the same price. The value of this work does not appear to be sufficiently appreciated by British geographers, and it is to be hoped that further support for the Society's undertaking will be forthcoming.

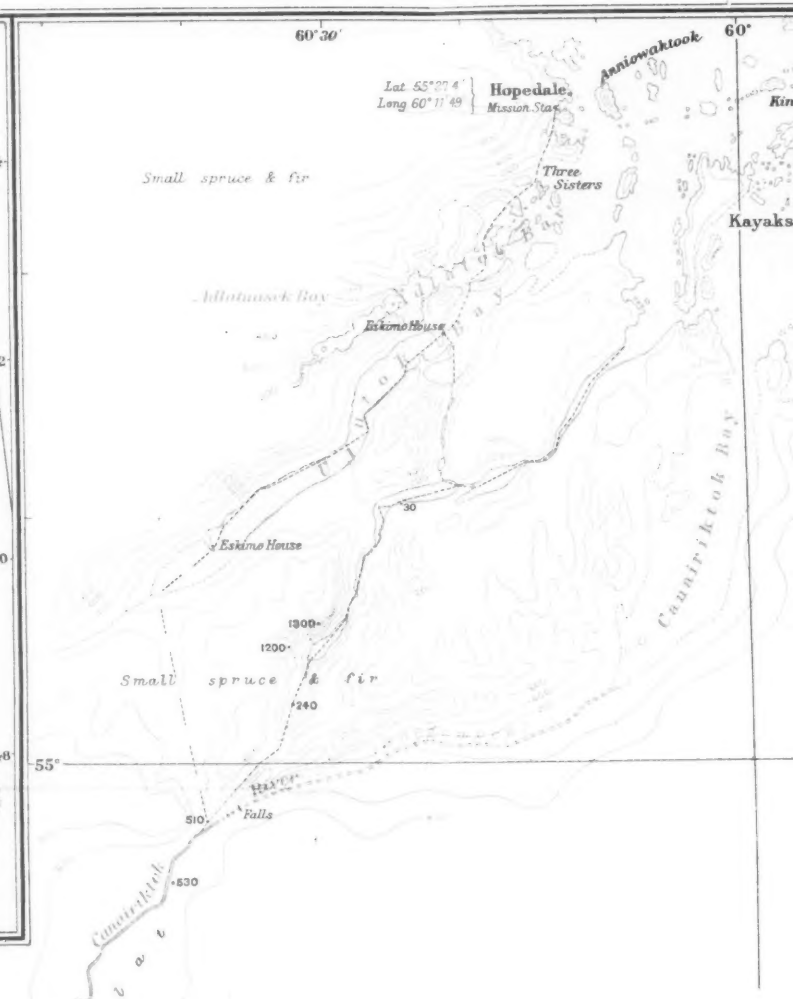
MEETINGS: SESSION 1929–1930

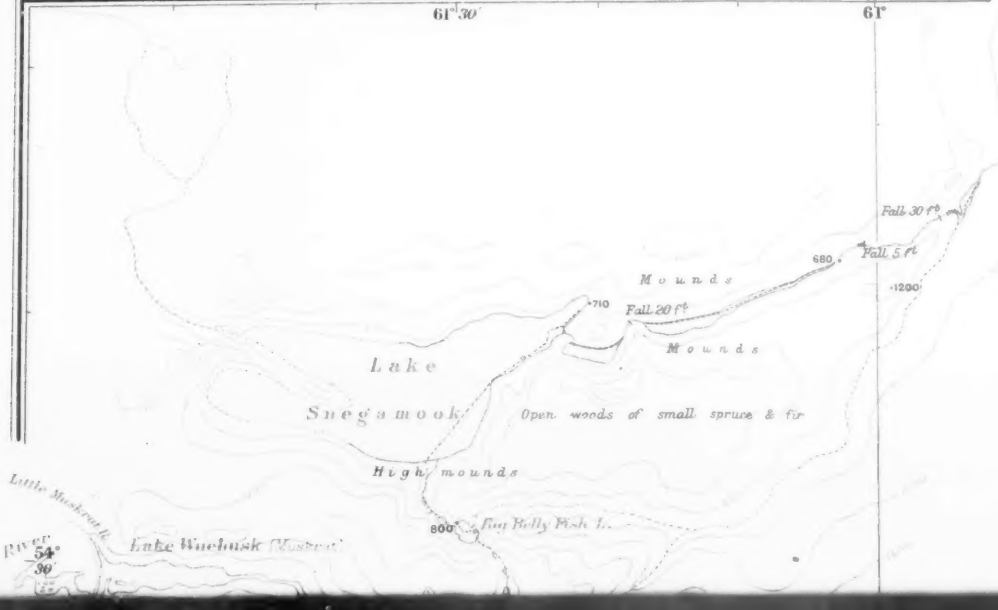
Fifth Evening Meeting, 13 January 1930. The President in the Chair

Elections: William Alexander Buyers, V.D., M.I.C.E.; John Redgwick Crossland; Mark Dineley; Lieut. David Maisey Eley, R.E.; Capt. Charles Gilbert Evans, R.E.; Lady Fisher; Frank Wall Griffiths; Frederick Alfred John Harding; Capt. W. H. Henshaw, R.A.; Miss Freda Jarvis; Frank S. Leng; Frederick G. Leonard; The Hon. Mrs. Maguire; Capt. Albert Edward Middleton, F.Z.S.; John Nash; Frank Alan Railton, B.SC.; Miss Shanti Rangaroo; Brig.-Gen. the Hon. Robert White, C.B., C.M.G., D.S.O.

Paper: Forests and Plants of the Anglo-Egyptian Sudan. By Dr. T. F. Chipp







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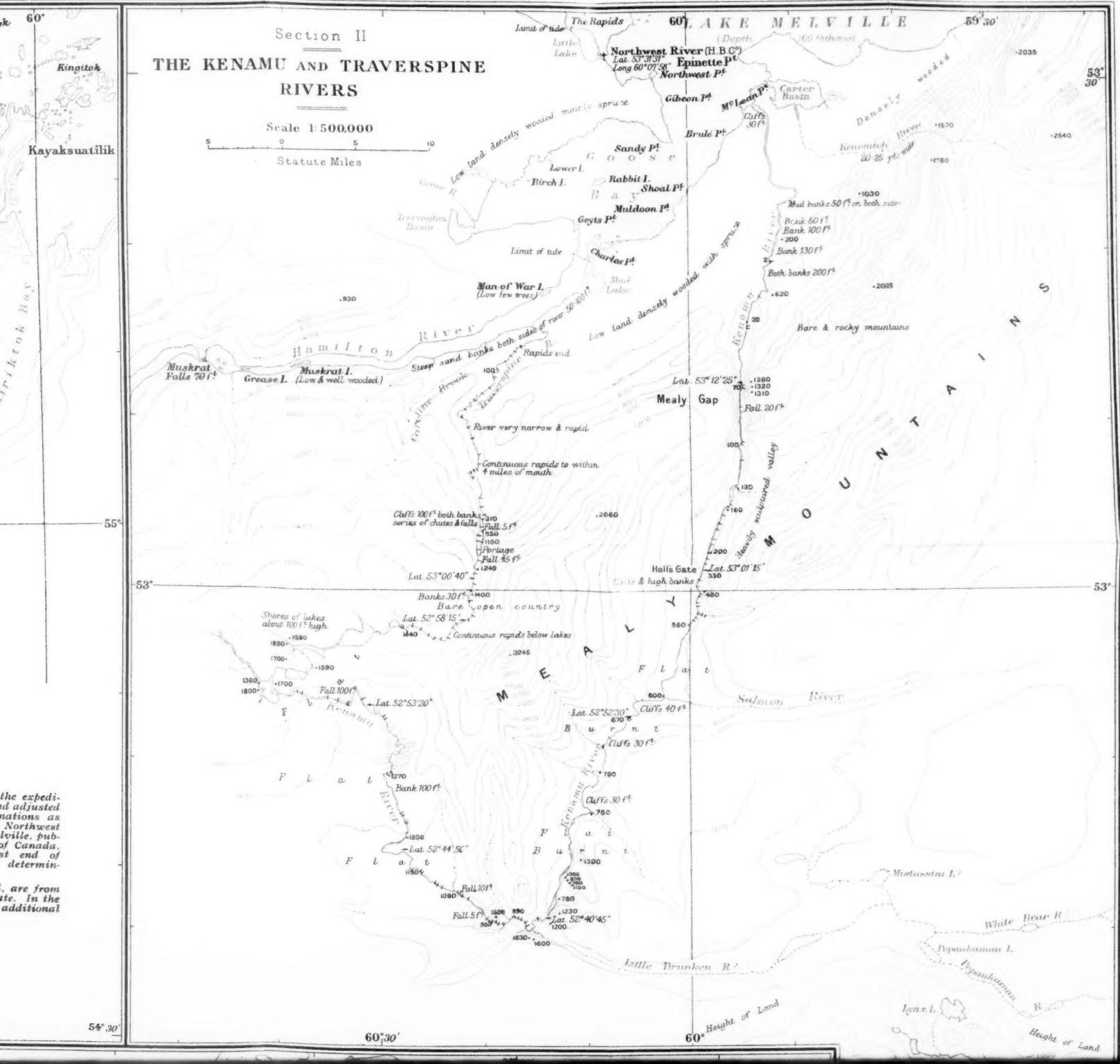

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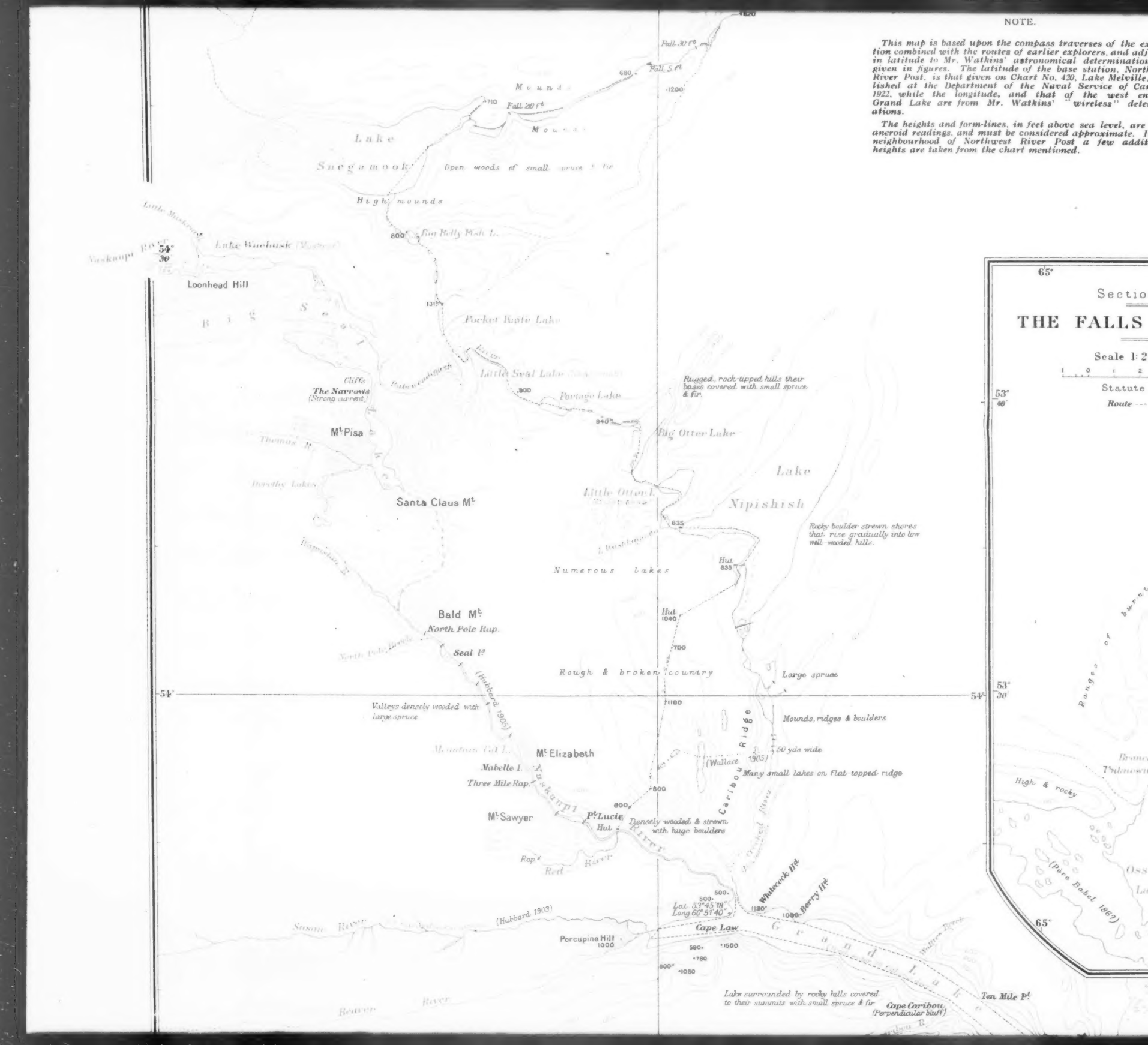
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Fall 30 ft
Fall 5 ft
Fall 20 ft
Mounds
Lake
Snegamook
Open woods of small spruce & fir
High mounds
Big Rolly Wash L.
Lake Winokapau (Western)
Loonhead Hill
Big Sea
Pocket Knife Lake
Little Seal Lake
Portage Lake
Big Otter Lake
Little Otter L.
Lake
Nipishish
Cliffs
The Narrows
(Strong current)
Mt Pisa
Santa Claus Mt
Dorothy Lakes
Numerous lakes
Rugged, rock-topped hills their bases covered with small spruce & fir.
Rocky boulder strewn shores that rise gradually into low well-wooded hills.
Hut
Bald Mt
North Pole Rap.
Seal I.
Rough & broken country
Large spruce
Valleys densely wooded with large spruce
Mountain Cat L.
Mt Elizabeth
Mabelle I.
Three Mile Rap.
Caribou Ridge
Mounds, ridges & boulders
50 yds wide
(Wallace 1905)
Many small lakes on flat topped ridge
Mt Sawyer
Pt Lucie
Hut
Densely wooded & strewn with huge boulders
Rapid
Red River
Whitecrock Hd
Berry Hd
Lat. 53°45'18"
Long 60°51'40"
(Hubbard 1903)
Susan River
Porcupine Hill
1000
Cape Law
Grand Lake
Lake surrounded by rocky hills covered to their summits with small spruce & fir
Cape Caribou
(Perpendicular bluff)
Ten Mile Pt
Beaver River
Section
THE FALLS
Scale 1:2
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Route
Hugh & rocky
(Père Babel 1867)
53° 40'
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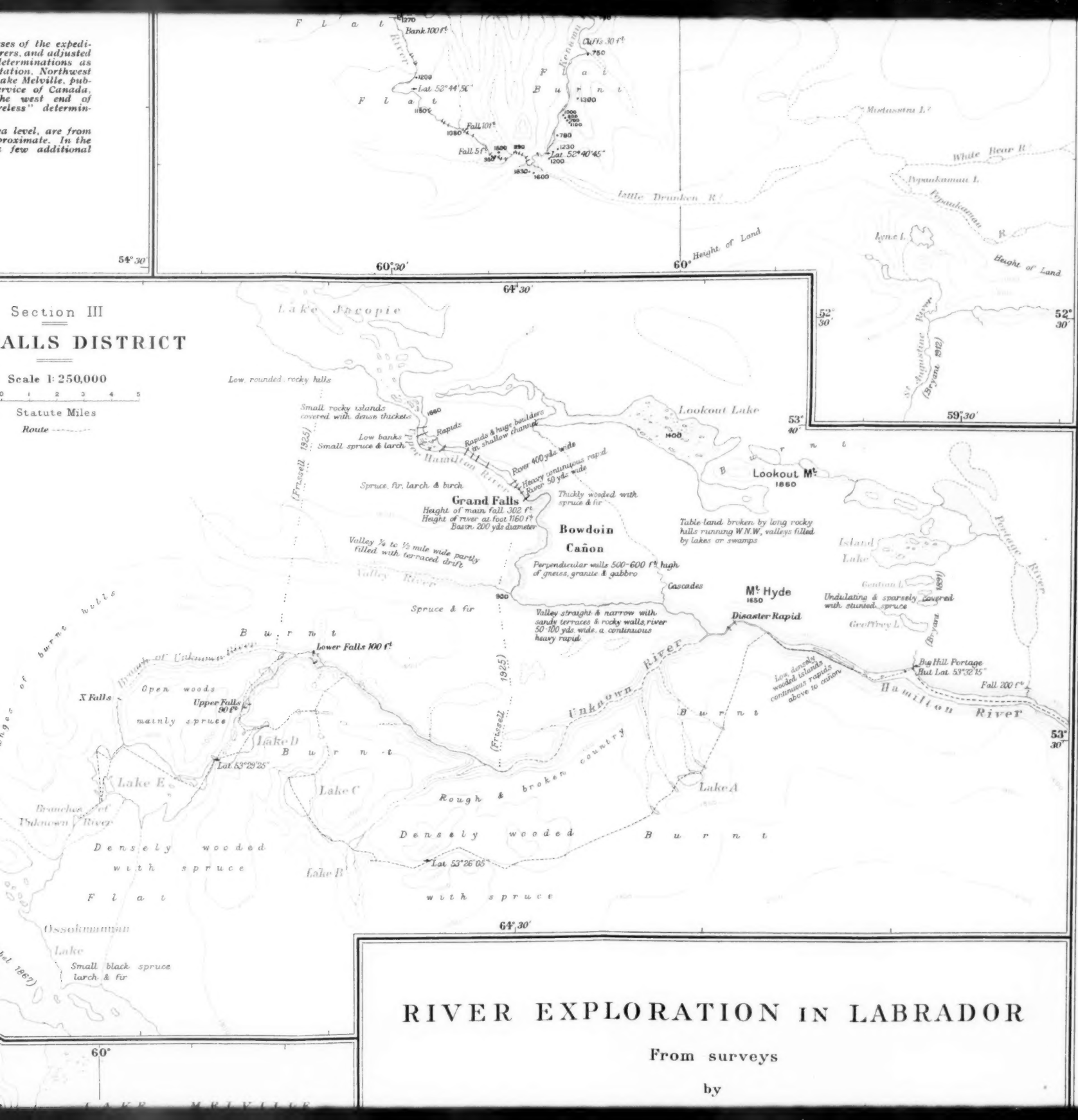

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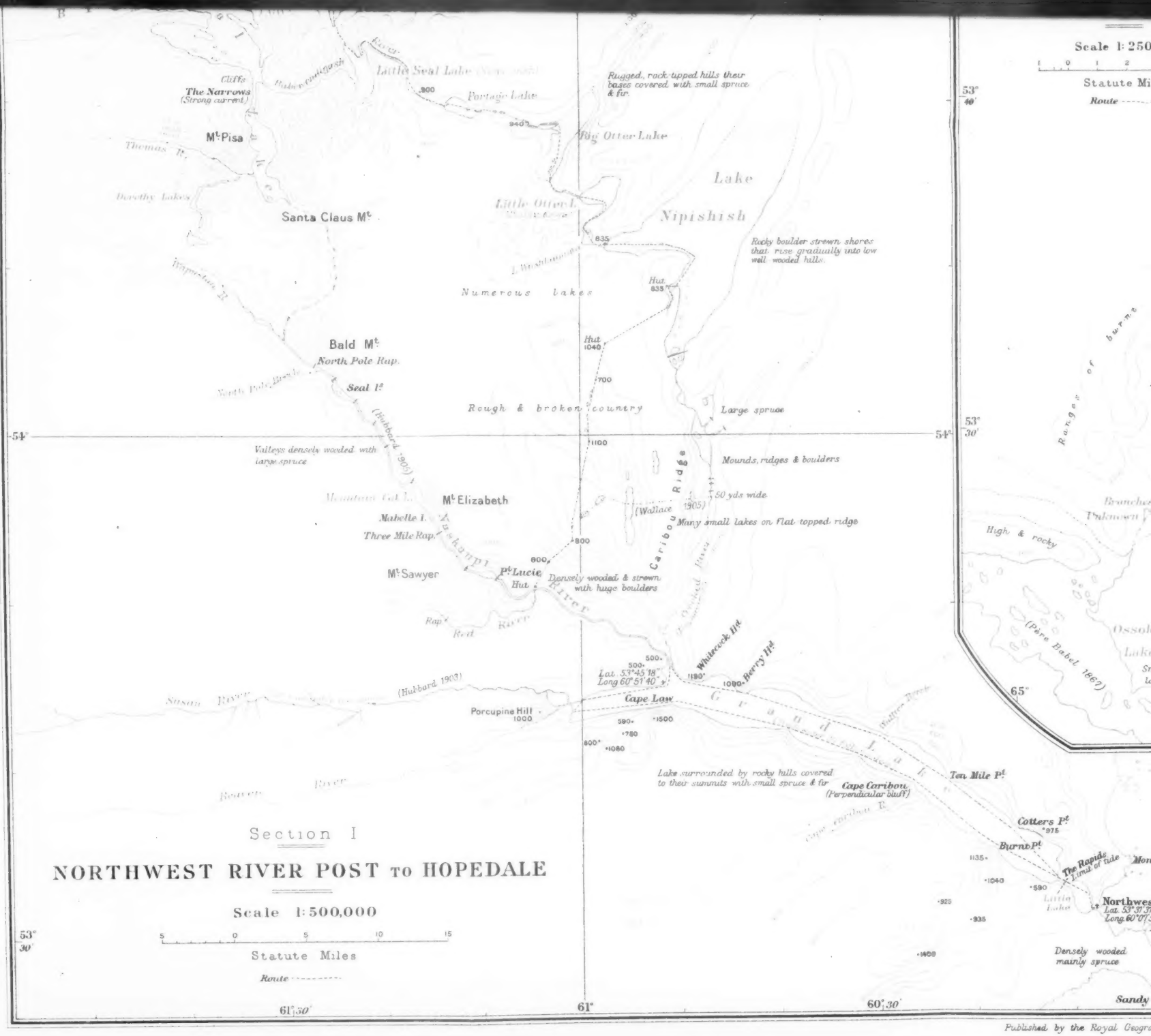

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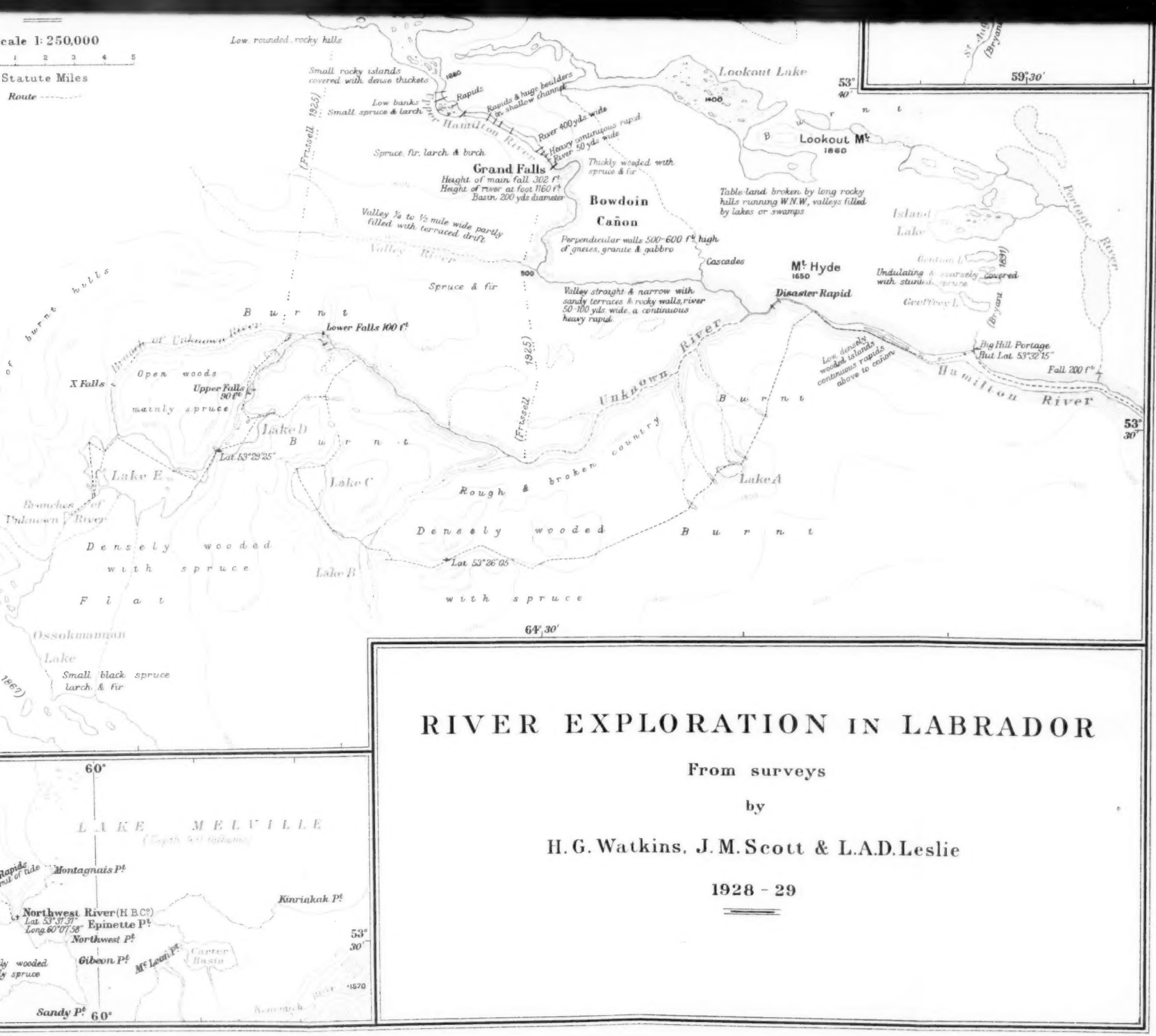

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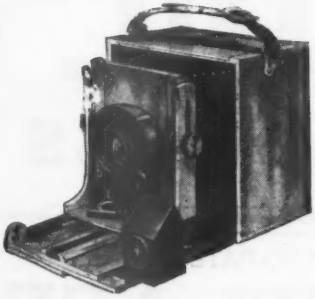

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ROYAL GEOGRAPHICAL SOCIETY: NOTICES

EVENING MEETINGS IN THE AEOLIAN HALL

Monday February 10 *at* 8.30 *p.m.*
BOUNDARY WORK IN THE BALKANS. *By Colonel F. L. Giles*

Monday February 24 *at* 8.30 *p.m.*
THE ITALIAN EXPEDITION TO THE KARAKORAM. *By H.R.H. the Duke of Spoleto*

Monday March 10 *at* 8.30 *p.m.*
THE EASTERN GATE TO INDIA. *By Mr. F. Kingdon Ward*

Monday March 24 *at* 8.30 *p.m.*
EXPLORATION IN THE KARAKORAM AND KUN LUN. *By Dr. Emil Trinkler*

AFTERNOON MEETING IN THE COUNCIL ROOM R.G.S.

Monday February 17 *at* 5 *p.m.*
CLIMATIC CONDITIONS IN THE TARIM BASIN. *By Lt.-Col. R. C. F. Schomberg*

THE NEW BUILDING

Thanks to an exceptionally fine and warm January the building has made excellent progress. The outer walls of the Hall are built to the cornice; the balcony is cast in reinforced concrete, and the moulds for the roof beams are in course of erection. The shuttering for casting the library floor is in position, and the lift shaft is nearly completed.

Owing to the alterations at the east end of the old building required to connect with the new, the Working Library, Staff, and Catalogues are temporarily removed to the Reading Room; the New Books and Journals from the Reading Room are removed to the Fellows' Library; and the offices of the Librarian and Assistant Librarian are removed to the Tea Room, which is temporarily closed; but tea will be served as usual in the two Smoking Rooms.

The Instruction Rooms are temporarily closed, and Mr. Reeves has moved his work of Instruction to the room over the Gentlemen's Smoking Room.

By Order of the Council, ARTHUR R. HINKS, *Secretary*.

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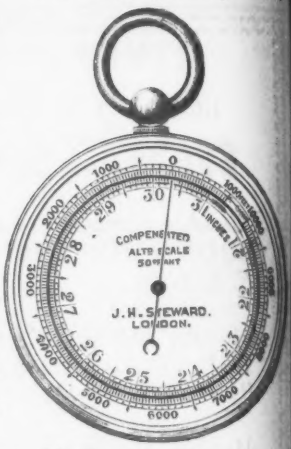

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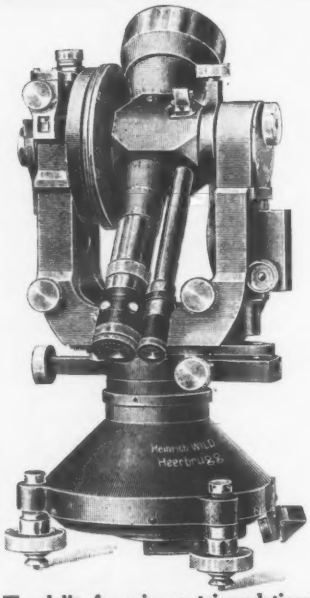

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